Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY JANUARY 1994 $3.75

Plugged-In Medicine

HOW INFORMATION TECHNOLOGY WILL CUT THE COSTS AND IMPROVE THE QUALITY OF HEALTH CARE

ALSO IN THIS ISSUE:

- TOWARD REMEDYING THE ORGAN SHORTAGE
- BLIMPS ON THE RISE
- BUCKYBALLS: THE THIRD COMING OF CARBON
- LESSONS ON INDUSTRIAL POLICY FROM BRAZIL

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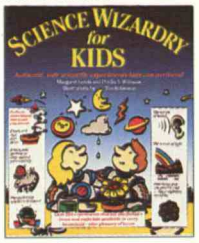
New! Science Wizardry for Kids

by Margaret Kenda and Phyllis S. Williams



More than 200 authentic, safe experiments that use everyday, inexpensive materials. Kids will get to know the thrill of discovery by looking at their immediate world: making toy boats, brewing sun tea, growing violets, collecting rocks. Includes step-by-step instructions and glossary.

Ages 9-12, Spiral-bound, 316 pages, $13.95

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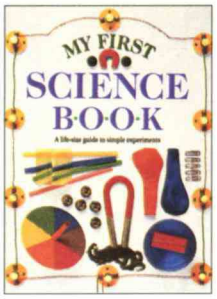
by Angela Wilkes



Kids can learn about the weather by making a rain gauge, barometer, and wind vane, or test acidity and alkalinity with their own litmus test. Includes instructions with color photographs, and clear explanations of why things happen. Over a dozen experiments.

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175 Science Experiments

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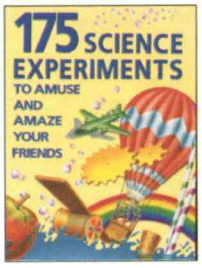
Illustrated by Kuo Kang Chen and Peter Bull

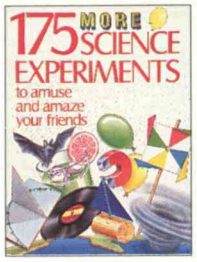


This collection of experiments will amuse and amaze every young scientist. Each page is filled with detailed full-color illustrations, photographs, and instructions on how things work and why things happen in our everyday lives.

Ages 8–12, Paperback, 172 pages, $12.00

New! 175 More Science Experiments

by Terry Cash, Steve Parker, & Barbara Taylor

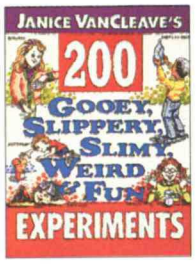


A sequel to the popular *175 Science Experiments*, this book brings further enjoyment to curious kids. Within four main sections—Sound, Electricity, Simple Chemistry, and Weather—it provides a lively menu of experiments, tricks, and things to make.

Ages 8–12, Paperback, 172 pages, $12.00

New! 200 Gooey, Slippery, Slimy Experiments

by Janice VanCleave

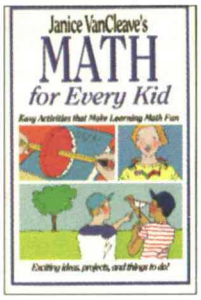


Zany, wacky, entertaining, this book engages children's imaginations while answering their favorite questions about the environment. Your kids will have so much fun conducting these 100% fool-proof experiments they'll forget they're learning.

Ages 8–12, Paperback, 172 pages, $12.00

Math for Every Kid

by Janice VanCleave

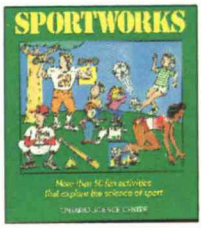


Easy activities that make learning math fun! Packed with illustrations, *Math for Every Kid* uses simple problems and activities to teach kids about measurements, fractions, graphs, geometry figures, problem solving and more!

Ages 8–12, Paperback, 215 pages, $10.95

Sportworks

by the Ontario Science Centre
Illustrated by Pat Cupples

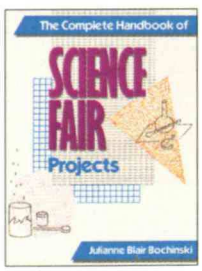


Why does a curveball curve? What makes a good football helmet? How do figure skaters spin so fast, and don't they get dizzy? You find answers to these sports mysteries and much more in this fun-filled book by the world-famous Ontario Science Centre.

Ages 8–12, Paperback, 96 pages, $8.95

The Complete Handbook of Science Fair Projects

by Julianne Blair Bochinski

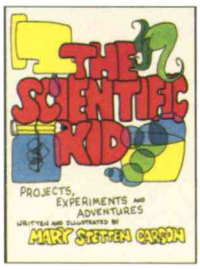


The only book you'll need for selecting, preparing, and presenting award-winning science fair projects. Written by a veteran contestant and judge, this step-by-step guide describes 50 projects in detail and suggests 500 other topics suitable for grades 7 and up.

Ages 12 and up, Paperback, 206 pages, $12.95

The Scientific Kid

Written and illustrated by Mary Stetton Carson
Photographs by Sing-Si Schwartz



A collection of 35 fun experiments and projects to teach your kids some basic scientific concepts, from a vinegar and baking soda reaction to static electricity.

All ages, Spiral-bound, 78 pages, $13.00

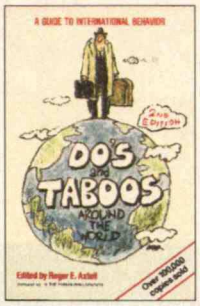
Snafooz Puzzles

These squishy foam puzzles will test your mettle and creative energy with dozens and dozens of complex shapes to build and rebuild. Six different levels to master, from easy to brain buster!

Ages 8 to adult, Package of 6, $6.95

Do's and Taboos Around the World

Edited by Roger E. Axtell

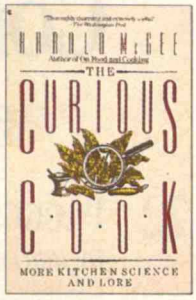


This fascinating guide helps thousands of high-powered executives and tourists avoid the missteps and misunderstandings that plague the world traveler. It includes facts and tips on protocol, custom, etiquette, hand gestures, body language, idioms, and gift-giving.

Paperback, 200 pages, $12.95

New! The Curious Cook

by Harold McGee

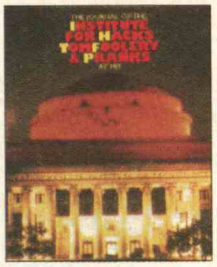


How can you keep the green in guacamole and pesto sauce? What's the best way to make fruit ices? Packed with fascinating scientific lore, *The Curious Cook* answers these questions and more to help the home cook make use of scientific discoveries about food.

Paperback, 339 pages, $13.00

Journal of the Institute for Hacks, Tomfoolery & Pranks at MIT

by Brian M. Leibowitz

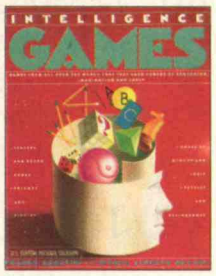


This hilarious book recounts the history, folklore, and ingenuity of MIT students in their quest for the ultimate prank. From welding trolley cars to their tracks to steers grazing atop the great dome, this journal captures the spirit and playfulness of a rich MIT tradition.

Paperback, 158 pages, $19.95

Intelligence Games

Edited by Roger E. Axtell

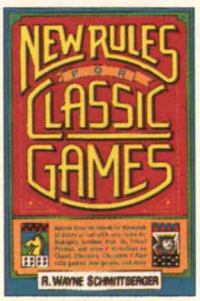


A collection of riddles, logic, boardgames, and enigmas from all over the world to test your powers of reasoning and savvy. A great book that will provide hours of fascinating fun.

Paperback, 185 pages, $15.95

New Rules for Classic Games

by R. Wayne Schmittberger



If rules are made to be broken, then dust off those old games lying dormant in your closet, because your game playing just got a lot more exciting! This book is a complete guide to hundreds of new twists and variations guaranteed to expand and enliven your game repertoire.

Paperback, 245 pages, $9.95

Puzzlegrams

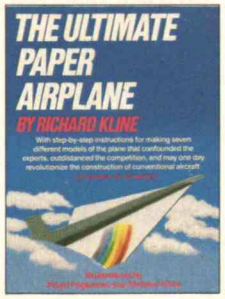
by Pentagram

A collection of 178 classic puzzles recreated by one of the world's leading design firms. The book is a stunning, four-color combination of design and conundrum. It appeals to all ages and levels of expertise—and challenges your intuition as well as your intellect.

Paperback, 187 pages, $15.95

The Ultimate Paper Airplane

by Richard Kline

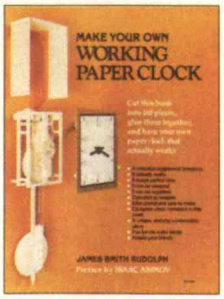


More than just a toy, the Kline-Fogleman airfoil earned its inventors two patents and was tested by NASA. Here is the story of its creation, along with the secrets behind its unmatched performance. Plus, instructions and patterns for making seven different models.

Paperback, 126 pages, $8.95

Working Paper Clock

by James Smith Rudolph



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TECHNOLOGY REVIEW
JANUARY 1994

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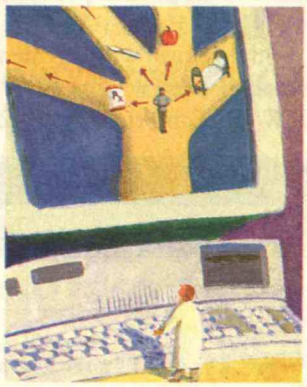

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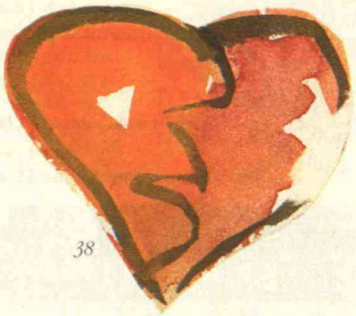

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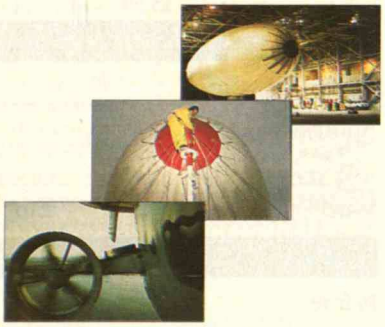

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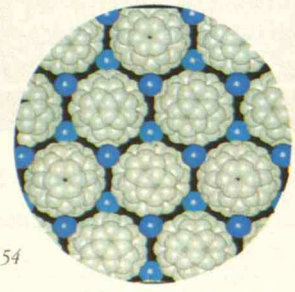

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COVER: JON MCINTOSH

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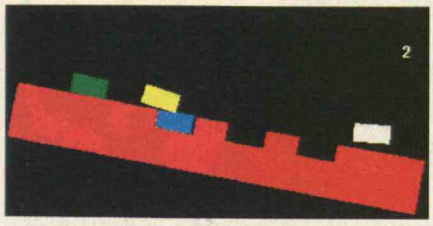

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First Line

Confessions of a Picky Eater

In Voltaire's *Candide*, the world-weary Lord Pococurante was impossible to satisfy. There was no poem, no play, no painting, no musical composition ever created—regardless of its acclaim elsewhere—that could earn his unqualified praise. "What a superior man," exclaimed the naive young traveler Candide. "Nothing can please him." But Candide's older and wiser companion had a different reaction. "The best stomachs," he observed, "are not those that refuse all food."

I was recently reminded of this passage after speaking with an environmental scientist who wished to write for *Technology Review*. He had some concerns. "You're developing quite a reputation," he told me, "as the country's second most difficult magazine to get into—after the *New Yorker*."

It's an honor to be put in the company, even if backhandedly, of what is arguably the world's finest magazine. But the scientist's statement also caused me to wonder: Is *TR* indeed a little too big for its britches? In our continuing quest for excellent articles, does our stomach refuse all food? Or, since we do manage to fill our pages, are we nevertheless insufferably picky eaters?

I reflected long and hard on these questions. And my answer, as comedian Steve Martin might conclude under similar circumstances, is: "Naah!"

Essentially what we ask is that our articles reflect good journalism. But imposing professional standards on nonjournalists—in our case, specialists in technology-related fields—is easier said than done. There are lots of casualties, not so much because of rejection by us but because many would-be authors, once they realize that the project may not be a walk in the woods, tend to disappear.

Technology Review's purpose is to provide a public forum for the knowledge and ideas of scientists, engineers, and related experts. But along with their erudition can sometimes come a little arrogance and, with regard to *TR*'s niche in publishing, some ignorance as well. The expert-author knows the informational needs of his or her colleagues, as well as what's required for professional journals—where papers (as opposed to articles) are submitted mostly on a take-it-or-leave-it basis and little or no editing occurs. That expert-author is usually unfamiliar with the editorial process—both its nature and extent—in the altogether different world of journalistic publishing, which serves a much broader audience. In fact, experts often use the word "journalistic" pejoratively, not as a descriptor of professions fully as complex, arduous, and thorough as their own.

Presenting a delectable and nourishing feast to our readers means having to send some courses back to the kitchen.

The results of good journalism usually make it look easy. But the fact is that great effort is required of writers and editors to produce a successful article, much as the labors of hundreds of professionals come together to make a compelling movie, in which scene after scene appears to have popped effortlessly into view. The reader of an article should similarly feel as if it fell from a tree, fully ripened, onto the page.

General—that is, nonspecialist—readers, like theater audiences, require smooth execution to remain absorbed. But although few moviegoers get up and walk out when a film is disappointing, general readers will quickly stop reading. Retaining that audience's attention requires abandoning the notions that first drafts become final drafts with only a few cosmetic changes, and that editors who think otherwise are mischievous or hypercritical.

Judge our criteria for yourself:

- *The golden mean.* An article should be neither too narrow and esoteric on the one hand nor too broad and ambitious on the other. The first would fail to interest most of our readers; the second would be vague and fail to satisfy them.
- *From each according to one's ability.* An expert author should tell a story and take a position appropriate to his or her profession and expertise. A scientist should not come on like a politician, for example, or vice versa.
- *Follow-through.* Authors shouldn't litter the manuscript with long digressions or leave gaping holes. If they believe, say, that a certain program is a model worth emulating, they should explain why.
- *An exercise in teaching.* Technical descriptions should be clear and logical, and backed up with enough data, examples, or anecdotes for readers to stay tuned. Jargon or specialized references, when unavoidable, should be defined.
- *Share the experience.* Similarly, judgments and opinions should be preceded by discussions of whatever convinced the author in the first place.
- *Do unto others.* Besides offering their own points of view, authors should also provide brief but fair depictions of "the other side"—alternative points of view—so that readers can put the issues in context and draw their own conclusions.

The above items boil down to two very simple requirements that don't seem so forbidding or exclusive: that the author be credible and that the argument be of high quality. We don't expect such excellence right away; it evolves through the outlines and drafts, with readily provided editorial help, that are the necessary precursors to the final product. Ultimately, what we need from the author is not flawless style but reasonable content. If that's what it means to be "difficult to get into," then we're truly serving our readers.■

—Steven J. Marcus

Letters

LIGHTENING UP ON DESIGN

"Toward Human-Centered Design" by David Norman (*TR July 1993*) brings to mind three examples of imperfect design from my own experience.

First, my Saab 9000, though a wonderful automobile in most respects, has a central control panel that contains 50 (I counted them) push-buttons for temperature, defrosting, station select, sound volume, and so on. Each button performs its function properly, but it is nearly impossible to use any of them without taking one's eyes off the road.

My second example comes from my job. I've been a professional pilot for over 20 years and currently fly the Boeing 757 and 767. A high level of automation gives these excellent airplanes capabilities that would have been remarkable a few years ago. However, the design breaks down when some significant change of plan is introduced, which may happen because of an equipment failure or, more commonly, because of difficulty with the air traffic control system or the weather. The problem is that unless the computer is reprogrammed in these situations, it is useless. And reprogramming must often be done while landing preparation is being completed, which is an extremely busy time.

My third complaint is that the "autopilot/flight director system" (APFDS) control panel on the Boeing 757 and 767 has a drawback similar to that of the control panel on my Saab. It consists of a few knobs for selecting things like airspeed and altitude and many identical square push-buttons. When properly selected, these push-buttons will cause the aircraft to respond exactly as the pilot wishes. But on portions of most flights, safety depends on the pilot's ability to look outside the aircraft to avoid hazards, and the APFDS panel can't be operated by feel.

Pilot technique has evolved to compensate for such less-than-ideal design. Pilots are being taught that when automation is no longer a help, they should disregard it and operate the plane as if it were a Piper Cub, or a bicycle, or even a lawn mower. My suggestion to designers is that less thought be given to precise control and more to allowing the operator to make decisions based on direct observation. Look to the primitive machines or tools that work well and emulate them.

For example, steering a car probably requires hundreds, perhaps thousands, of small wheel adjustments per mile. Though that's a lot of "control input," almost anyone can do it. But imagine steering a car by reading a computed drift angle on a keypad with your index finger. Almost no one could do it. Or consider something even simpler, like the screwdriver. Exactly how much torque should you use in a given situation? Who cares? Your hand and arm will tell you when the screw is tight enough.

WILLIAM M. FERREE
Mont Vernon, N.H.

TMI AS A NON-DISASTER

In "Learning from Technological Disasters" (*TR August/September 1993*), Wade Roush includes a rather extensive discussion of the 1979 core-melting incident at Three Mile Island. But having spent my entire career in the nuclear industry, I find it difficult to categorize TMI as a disaster. There was no loss of life, no life-threatening dose of radiation to the public or the operators, and no property loss other than the reactor itself. There was, however, psychological damage to the public in the vicinity of TMI, caused by the media and the special interest groups whose livelihood depends on encouraging the Chicken Little syndrome.

Also, Roush is wrong in suggesting that democracy has been left out of the process for regulating the nuclear power industry. The Nuclear Regulatory Com-

mission obtains formal technical opinions on all its actions from the Advisory Committee on Reactor Safeguards, a 12-member statutory body made up of independent consultants and people from academe and the industry. The five NRC commissioners, appointed by the president, must be confirmed by the Senate. Open hearings are held on all phases of the rule-making and licensing process. And finally, a lawyer aided by two technical members heads the boards that conduct adjudicatory licensing hearings. Anyone in the public with proper standing can participate in these licensing hearings, and the boards' findings can be appealed to an appeal board, the NRC, and the federal courts.

PETER J. DAVIS
Paris, Va.

UNWARRANTED CONFIDENCE IN CELLULAR PHONES

It's one thing to let the fox guard the henhouse, but it's quite another to let him lecture us on the best way to stand guard. That is what *Technology Review* has done in publishing a commentary by Norman Sandler, a consultant to the cellular telephone industry, on the scare over the health effects of such phones (*"Panic Gluttons," TR October 1993*).

Sandler says that biological effects "have never been seen at the power and frequency of cellular phones," but he neglects to add that no one has ever looked. When he writes that scientists asked to give their opinions during the scare could not "conclude with absolute confidence" that cellular phones do not cause cancer, he implies that we are a small step away from being able to guarantee safety. Nonsense. The truth is that the industry has spent virtually nothing on health research. The government has not done much more.

As a senior official of the Food and Drug Administration told the Cellular Telecommunications Industry Association last summer, "It is simply too soon to assume that cellular phones are perfectly safe, or that they are hazardous—either assumption would be premature. This is precisely why additional research is needed." The FDA also chastised CTIA for "an unwarranted confidence that these products will be found to be absolutely safe."

The irony is that Sandler is doing exactly the opposite of what he is preaching. By so grossly misrepresenting the scientific evidence on cellular phones, he guarantees public distrust of future assurances that technologies are safe. When a truly baseless fear comes along, people will still press the panic button.

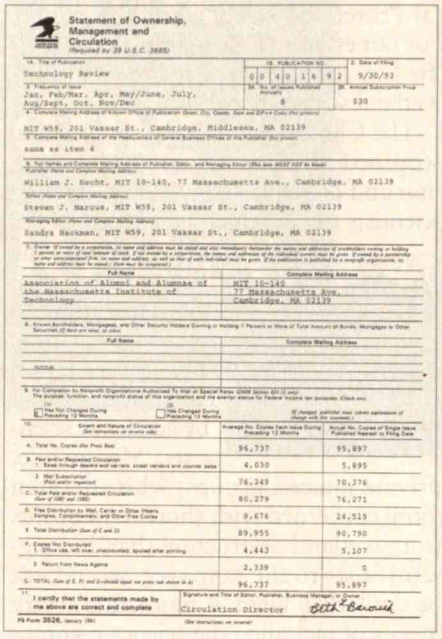
LOUIS SLESIN
Editor, *Microwave News*
New York, N.Y.

PROTECTING WETLANDS

As Douglas Thompson and Thomas Yocom note in "Uncertain Ground" (*TR August/September 1993*), resistance to wetland regulation is powerful. But it is useful to observe that in New England, where state wetland regulation preceded federal regulation by as much as 14 years, public support for local, state, and federal regulatory programs has been positive and strong. The federal agencies' failure to provide for public participation in developing the 1989 wetland delineation manual was probably a major error for many parts of the nation, as was the failure to insure that field personnel were adequately trained.

It's also worth pointing out that the segment of the agricultural community most vocal in its opposition to wetland regulation may be the one whose long-term interest is not in food but in land speculation for office parks, subdivisions, and shopping malls. After all, the soil maps that members of this community use as a tool identify wetland soils as high risk and low value for intensive agriculture.

Finally, science is just as important in dealing with wetlands as it is in dealing with farms or forests, and in the last year of the Bush administration the science community was excluded from the White House. Wetland scientists spent thousands of hours field testing the Quayle-Sununu wetland delineation manual independently and presenting evidence of its flaws to the Environmen-



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tal Protection Agency and the public. For our efforts, some of us were disqualified by Bush staffers as potential EPA wetland science panelists.

The Clinton administration has now reopened the door to scientific information and dialogue. However, in inviting scientists to participate in a recent series of seminars, the White House provided no budget to cover travel costs. This policy could limit participation by academic scientists. Meanwhile, private interest groups, who are often more concerned with short-term profits from wetland destruction than in long-term costs to the taxpayer, would not be similarly limited. A more satisfactory means of including the science community in forming federal wetland policy needs to be developed.

JOSEPH S. LARSON
Director, The Environmental Institute
University of Massachusetts
Amherst, Mass.

BIRDS IN JEOPARDY

In "Progress for the Birds" (*TR July 1993*), Samuel Florman states that because of the number of protected areas, including national forests, national wildlife refuges, and national parks, he is not pessimistic about the future for many bird species.

He seems unaware that most professional ornithologists, avian ecologists, and birders are concerned about the degraded state of habitat within these "protected" areas. Nor does he seem to know that the northern spotted owl and the marbled murrelet, for instance, are severely threatened by logging of old-growth forests in the Pacific Northwest, and deep-forest dwellers like the wood thrush are in serious trouble because of the fragmentation, which he extols, of eastern woodlands. It has also apparently escaped his notice that Partners in Flight, a major national effort involving federal, state, and private agencies, is under way precisely because there is disturbing evidence that many bird species are indeed declining, some precipitously. Unfortunately, Mr. Florman, in this particular column, fits the stereotype many biologists have of civil engineers, as people lacking knowledge of ecology.

ROBERT C. TWEIT
Tucson, Ariz.

NIH DILEMMAS

In "What the Doctor Prescribes" (*TR Interview, October 1993*), Bernardine Healy fails to address two basic dilemmas that have plagued the National Institutes of Health throughout its history. One is whether to fund research at a wide range of universities or concentrate on a few elite institutions. Despite its mandate to do the former, the NIH has opted for the latter. As a result, many universities cannot provide research opportunities for their teaching faculty. Meanwhile, elite schools hire hundreds of researchers who do little or no teaching.

The second dilemma is how to set funding priorities. The NIH now lets university applicants submit proposals of their choice, which are reviewed by experts in the specialty. But these reviewers are not experts in the needs of the nation's health care system or in the mission of the NIH. The billions of NIH dollars spent in this way for research on cancer, AIDS, diabetes, arthritis, and other diseases have produced disappointingly few useful results. The NIH's standard reply that it is laying a groundwork of basic knowledge has lost credibility after almost four decades.

WILLIAM G. ROTHSTEIN
Baltimore, Md.

VIRTUES OF VIRTUAL REALITY

In "Virtual Reality Check" (*TR October 1993*), Thomas Sheridan and David Zeltzer provide a thoughtful review of the current state of the art in the design and use of virtual environments. Granted, the field is not without challenges. Today's virtual environments fall far short of supplying visual, auditory, and tactile displays realistic enough to allow participants to suspend disbelief. Still, a great future lies ahead for virtual-environment technology.

The technology will be particularly beneficial for visualizing vast amounts of data and complex dynamic processes. Virtual-environment equipment also has the potential to significantly change the way we teach. Students could visit the Martian landscape, fly through an active volcano, or walk through the human body. Virtual reality will have interesting applications for the behavioral sciences as well, allowing participants to experience the world through the eyes and ears of others.

WOODROW BARFIELD
Interactive Computer Graphics and
Human Factors Laboratory
University of Washington

SCIENCE ON THE AIR

In "Children's Science Radio" (*TR Trends, October 1993*), Simson Garfinkel reports on kids' reactions to Kinetic City Super Crew, a series of science radio programs used in their school classrooms. The producers have since modified the series based on the students' feedback, and our company has assessed the impact of the commercial broadcast of four half-hour episodes for the National Science Foundation.

We found that fourth graders in three schools in southern Maryland who heard the weekly programs at home liked them and wanted to hear more. The radio series attracted children irrespective of their ethnic group, prior attitudes toward science, and degree of experience in scientific activities. Interestingly, girls were significantly more likely to listen to the programs than boys.

Content tests indicated that the programs significantly increased children's knowledge and understanding of science phenomena. Listeners also reported doing more science activities at home during the four-week broadcast period.

BARBARA N. FLAGG
Director, Multimedia Research
Bellport, N.Y.

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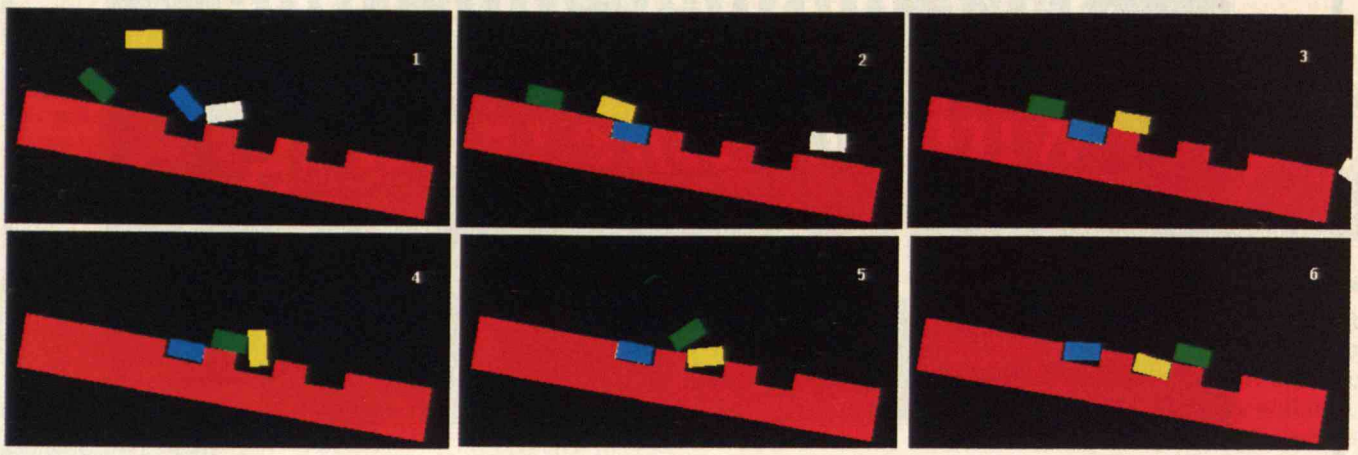


Shake and Make

A computer model mimics the way product parts fall into a vibrating pallet in preparation for robotic assembly. The model could help engineers create a more efficient manufacturing process and design items accordingly.

Manufacturers who use robots are continually trying to find more efficient ways to transfer large numbers of parts onto assembly lines in an orderly fashion. Engineers usually rely on vibration to separate, say, 5,000 bolts that come jumbled in a cardboard box, so that a robot arm can find one bolt at a time, pick it up, and attach it to the product moving down the line.

Taking this idea one step further, MIT researchers working with Polaroid Corp. are developing ways to use vibration to bring parts together. By harnessing the "gross behavior" of parts—the way they move in bulk—manufacturers can shake the parts into near self-assembly.

Mark Jakiela, assistant professor in the Department of Mechanical Engineering, Karl T. Ulrich, associate professor in the Sloan School of Management, and Paul Moncevicz, a former graduate student in the Department of Mechanical Engineering, have recently patented this process, dubbed "shake-and-make" assembly. Working with Polaroid engineers at the company's camera-assembly factory in Norwood, Mass., the researchers have demonstrated the process using existing machinery.

Consider the path of a pinwheel, a circular camera part the size of a coin, on a conventional Polaroid assembly line. The pinwheel is dumped in bulk into the automated part-orienting system (APOS), which spills about 100 or so units every few seconds onto a gently vibrating, slightly declined pallet with custom-shaped cavities on its surface. After the cavities are filled, the pallet moves down the line to an assembly point, where a programmed robot picks up one pinwheel at a time and attaches it to the work in progress. The same process is repeated for the next part—another relatively simple piece called the trimslide—which finally ends up on top of the pinwheel in the camera.

In 1991 Jakiela and Ulrich recognized that the assembly could be speeded if a pallet for one part, such as the pinwheel, waited for a "template"—a pallet with holes rather than cavities—to be placed on top of it before moving to the assembly station. Together with Moncevicz they set up a system in which the APOS shakes the trimslides over a thin template set directly above the pallet. The template catches the trimslides so that they match up with the pinwheel, as dictated by the camera design. The robot then grips both parts at the same time and attaches them to the camera in one move rather than two.

For every two bulk parts successfully processed in this way, one fewer $80,000 robot would be needed, Jakiela says. But he points out that the system still has a significant problem: the templates and pallets don't always fill up with parts. About half of the cameras end up missing parts, which must be added later. He says that manufacturers would demand efficiencies of at least 70 percent. The problem cannot be resolved simply by vibrating the templates and pallets for a longer period, because, as the holes start filling, it becomes harder for parts to locate empty holes. After an average of three minutes, the likelihood of parts finding unfilled holes diminishes greatly. Jakiela points out, furthermore, the number of missing parts should rise with each additional stacked pallet, since that adds more opportunities for holes not to fill completely.

To examine these probability problems, Jayaraman Krishnasamy, a graduate student working with Jakiela in the Computer-Aided Design Laboratory at MIT, is developing a computer model that mimics the way a part falls into a pallet. Krishnasamy says that this model could help engineers better understand the process and design pallets more likely to capture parts consistently. (Jakiela, Ulrich, and Moncevicz built their pallets by trial and error.) The model could also allow designers to create parts to shake-and-make specifications, he believes.

ILLUSTRATION: JAYARAMAN KRISHNASAMY

Such "design for manufacturing," while acclaimed by many in the manufacturing community, is not standard operating procedure. Therein lies a second problem with the shake-and-make process: manufacturers "want to have certainty about the locations of things; they want to be able to grasp things if they need to," Jakiela says. He calls the shake-and-make process "counterintuitive" to conventional manufacturing wisdom: it lets disorder create its own order.—*CATHY OLOFSON*

DESTROYING CANCER WITH...CANCER?

Think of it as fighting fire with fire. In an experimental treatment for cancer that uses genetically engineered cancer cells, Richard Mulligan, a professor of biology at MIT and molecular biologist at the affiliated Whitehead Institute for Biomedical Research, together with physicians at the Johns Hopkins Medical Institutions, hopes to stimulate patients' immune systems to stop the growth of kidney tumors.

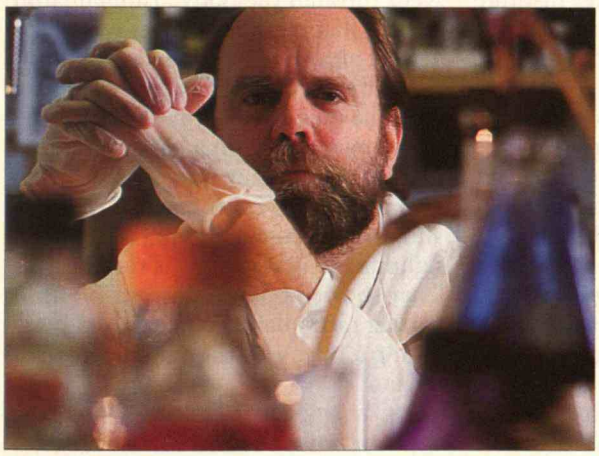
The researchers chose kidney cancer in part because past experiments have shown that the cells of kidney tumors tend to be more susceptible to immune attack than the cells of some other tumors. The experiment is one of more than half a dozen cancer-fighting gene-therapy experiments that are being conducted by researchers nationwide.

The Mulligan team's approach involves inserting an extra gene into kidney cancer cells, irradiating those cells so they cannot reproduce, then injecting them into cancer patients. The gene makes a potent hormone-like substance called gm-CSF (granulocyte-macrophage colony stimulating factor). When the irradiated cells—which remain alive for a short time—reach the tumors, the gm-CSF spurs rapid growth of disease-fighting white blood cells called granulocytes and macrophages.

Mulligan explains that the white blood cells should focus their attack on tumor cells because cancer-specific "markers"—molecules that appear on the surfaces of the injected tumor cells—will stimulate the immune system to recognize only tumor cells as "foreign." Normal cells should escape damage since they don't carry such surface markers.

Mulligan's group calls the treatment a vaccine because the goal is the same as with a traditional vaccine: to stimulate an immune reaction. But, unlike ordinary vaccines, the first aim of the anti-cancer vaccine is to cure existing disease, even though it might also prevent future tumor growth.

The results from studies on mice—reported recently in a paper in the *Proceedings of the National Academy of Sciences*—were encouraging, Mulligan says. In one set of tests, the researchers found that by first injecting the mice with engineered tumor cells, they could block the growth of malignant cells injected later. In mice already burdened with well-established tumors, the researchers found



Biologist Richard Mulligan has developed a gene-therapy treatment that might spur the growth of disease-fighting white blood cells to combat human kidney cancer.

PHOTO: MARK OSTOW

that injection of the engineered cells not only killed off cancerous cells but also caused "potent, long-lasting, and specific antitumor immunity."

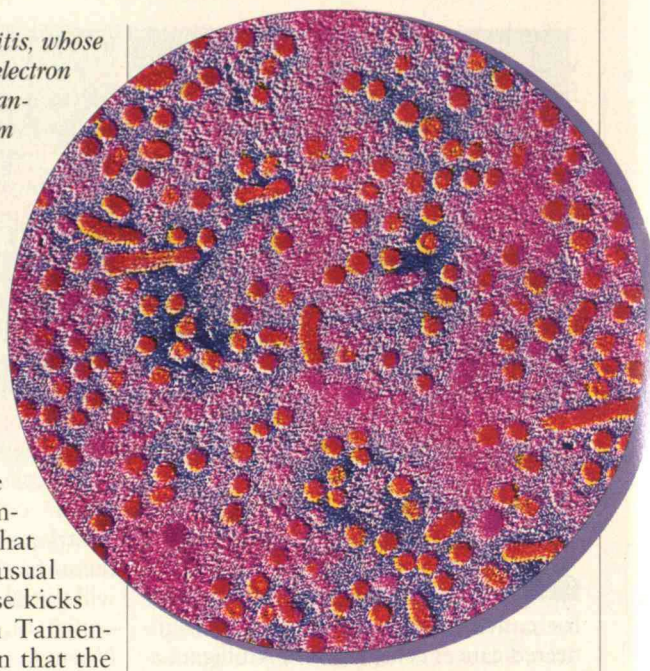
In accordance with FDA protocols, the next research step is to assess only the safety and appropriate dosage levels of the treatment in humans. Glenn Dranoff, a postdoctoral fellow in Mulligan's laboratory and the paper's lead author, says that the first patients—24 people who have failed all the standard treatments for kidney cancer—should have started treatment by late 1993. It is anticipated that half the group will receive injections of engineered cancer cells, while the remaining control subjects should receive irradiated cells not engineered with copies of the gm-CSF gene. The first human trials are sponsored by Somatix, a small biotechnology firm based in Alameda, Calif., that Mulligan helped found.

Following the results of the first trial, which are expected to take one to one-and-a-half years, the researchers hope to move on to larger FDA-approved trials to determine the treatment's effectiveness on kidney cancer. Mulligan's group would also like to begin similar experiments at Massachusetts General Hospital in patients with more common tumors: those of the breast, lung, and pancreas. Such studies, however, would require a new round of approvals from both the National Institutes of Health and FDA. That could take months and necessitate additional animal experiments.—*ROBERT COOKE*

CANCER AND THE IMMUNE RESPONSE: A CHEMICAL LINK?

Scientists have known for years that tissue inflammation and chronic infection boost a person's risk of cancer. Chronic hepatitis can lead to liver cancer. Frequent urinary tract infections often precede bladder cancer. But no one knows why.

Part of the key to answering the puzzle may be a form of nitrogen oxide called nitric oxide (NO), says Steven Tannenbaum, professor in the MIT Chemistry Department and the Division of Toxicology. He and his colleagues were the first to prove that humans and other mammals can synthesize NO and that they produce more than usual when their immune response kicks into action. Researchers in Tannenbaum's lab have also shown that the presence of NO can cause cell death and DNA damage, both of which can lead to the development of cancer cells. So, says Tannenbaum, it's possible that infection or inflammation spurs production of NO, which in turn ignites the development of cancer cells.



Diseases such as chronic hepatitis, whose viral agent is observable in this electron micrograph, sometimes lead to cancers. Chemist Steven Tannenbaum is studying whether the cancers start because of DNA changes caused by bodily surges of nitric oxide produced during the immune response.

If he is right, many cancers could be prevented. By reacting with the enzyme that produces NO or by mopping up NO, drugs might block its overproduction or protect healthy cells against it. The job ahead for Tannenbaum is to determine whether animal studies and human clinical and epidemiological studies bear out his hypothesis. Last summer, the National Cancer Institute awarded him some $1 million a year for the next five years to conduct such research.

While Tannenbaum is now considered a pioneer, some scientists once thought his ideas were off the wall. His story starts with two other nitrogen oxides, nitrate and nitrite. In the mid-1970s, cancer researchers pointed to these closely related nitrogen oxides, which convert readily into one another, as precursors of carcinogenic compounds. Conventional wisdom held that nitrogen oxides were created only in the atmosphere or by bacteria, and that nitrate and nitrite made their way into the body through foods such as bacon and hot dogs.

But Tannenbaum proposed that animals could synthesize these nitrogen oxides. By measuring how much nitrate and nitrite animals and people ate and how much nitrate they excreted, he determined that much more came out than went in. (In the body, nitrite ends up as urinary nitrate.) To answer skeptics who replied that bacteria in the gut were responsible for the excess, Tannenbaum fed his subjects a tracer form of nitrogen. By following the tracer as it went through the body, Tannenbaum proved that mammal tissues were converting nitrogen to nitrate.

He then went on to connect nitrate with the immune system. Prompted by dramatic increases in a patient's nitrate excretion following a major infection, Tannenbaum's team guessed that the subject's immune system, which was fighting the infection, was responsible. They showed this conclusively by stimulating rats' immune systems and measuring a huge elevation in nitrate production.

NO's role in this process became apparent when Michael Marletta, now a

PHOTO: TEKTOFF RHONE/MERIUEX/CNRI

professor of medicinal chemistry and pharmacology at the University of Michigan but then an associate professor in the Department of Applied Biological Sciences at MIT, concentrated on finding which immune-system cell accomplished nitrate formation. His conclusion: the macrophage, a cell that primarily eats dead cells and other potentially harmful material. Zooming in closer, in 1987 he found that a previously unknown enzyme within macrophages alters the amino acid arginine to form NO. When that chemical combines with the water present in all animal tissues, it produces nitrate and nitrite.

This breakthrough led other scientists to find that NO could also form in other cells. Several teams then determined that NO acts as a chemical signal in various bodily processes, including digestion, heart function, and penile erection. Discoveries multiplied and in 1992 *Science* named NO the "molecule of the year" in recognition of its central role in human physiology.

Sinister Surges

As a chemical signal, NO usually acts in ways that help a body respond to its environment and stay healthy—for instance, by helping to regulate blood pressure. But when it surges in response to challenges of the immune system, its effects may be sinister. "Nitric oxide that's formed in the immune system is produced in tremendous quantities," which in turn convert to two intermediate compounds on the way to becoming nitrate, explains Tannenbaum. At least in the test tube, the intermediate compounds react easily with many cell materials, including DNA. Sometimes they react in ways that kill cells. Other times they react with DNA in ways that cause cell mutations. Both events can give rise to cancer cells.

Now Tannenbaum is trying to find out if the intermediate compounds kill cells and cause mutations in mammals. He and his colleagues at MIT and the National Cancer Institute are developing animal models to study what happens when huge amounts of NO are produced. They're breeding mice whose livers, for instance, harbor unnaturally large amounts of the enzyme that plays a critical role in the formation of NO. If these animals show an unusually high propensity for liver cancer, the evidence against NO will mount.

—*Leslie Brunetta*

Trends

Remaking Mars in Earth's Image

Mars is the solar system's most earthlike planet, with a surface area roughly equal to that of earth's land masses, but it has a range of temperature and humidity similar to that of Antarctica and an air pressure so low that on earth it would be considered a vacuum. Thus, to carry out extended human explorations of Mars—which mission planners at Martin Marietta Aerospace and other space organizations around the world say could be launched in less than a decade—a team of astronauts would need an ample supply of air, water, and food.

Most methods for supplying these basic necessities are impractical: continuously shipping new supplies from earth would be prohibitively costly. And the most frequently cited option—building huge domed living quarters such as those used in the recent Biosphere 2 experiment, and using pressurized space suits to explore the surface—would be both cumbersome and confining.

Some scientists are promoting a radical alternative: transforming the entire planet to make it more habitable by humans. Such a concept is not new—"terraforming" Mars has been discussed by scientists and described by science-fiction writers for decades. But space researchers Christopher McKay of the Ames Research Center of the National Aeronautics and Space Administration (NASA) and Richard Zubrin of Martin Marietta, among others, now suggest that deliberately triggering massive global climate change is within reach of present technology. Their calculations show that the first step—raising the atmospheric pressure and surface temperature to create a "shirtsleeve" environment for humans—could be achieved in a few decades.

The key to such a transformation would be to trigger the kind of disequilibrium that many scientists fear the human race may be inadvertently bringing about here on earth: a runaway greenhouse effect. Thus, an attempt to terraform Mars could not only create desirable new real estate for human pioneers but also provide unprecedented tests of hypotheses about global warming—though the answers might not come in until it's too late to reverse the process on earth.

Manufacturing greenhouse gases on Mars could trigger a runaway global-warming effect that could make the frigid planet more hospitable to humans within a few decades.

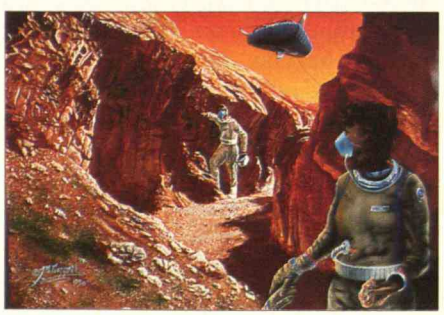
Terraforming would begin, say McKay and Zubrin, by introducing enough greenhouse gases, such as chlorofluorocarbons, into the atmosphere of Mars so that trapped solar heat would raise average surface temperature by about 4 degrees Celsius. This could be done by building factories on the surface of Mars to manufacture chlorofluorocarbons out of their elemental constituents, mined from the Martian air and soil. The factory would require about 1,000 megawatts of power, the output of one large nuclear power plant.

That 4-degree increase would be enough to produce a runaway effect: the rising temperature would cause some of the carbon dioxide frozen in the south polar cap of Mars to vaporize. Adding carbon dioxide—itself a greenhouse gas—to the atmosphere would further raise surface temperatures, which in turn would melt more of the frozen gas. The effect would continue until the entire polar cap was vaporized.

Although the volume of the polar ice cap is known only as a crude first approximation because of uncertainties about the average ice depth, Zubrin and McKay calculate that the resulting greenhouse effect would probably produce an average temperature rise of about 70 degrees Celsius, enough to bring it within the range of human comfort. It would also melt ice to start the planet's waters flowing once again and raise the atmospheric pressure from less that 10 millibars to about 200 millibars—one-fifth of sea-level pressure on earth and equivalent to that on some mountaintops where humans easily survive, though they would have to rely on scubalike breathing devices to supply oxygen. In fact, the more difficult step of introducing enough oxygen into the air to make the planet truly earthlike—mainly by planting trees, which take in carbon dioxide and give off oxygen—may take several centuries.

Beyond the question of feasibility, some scientists believe that ethical issues regarding the possible presence of indigenous Martian life need to be addressed before humanity undertakes any such missions. In fact, surface evidence points to a past when Mars was warm and had a dense atmosphere.

Adding enough oxygen to make Martian air breathable—mainly by planting trees—could take centuries. In the meantime, explorers would have to wear scuba-like devices.



ILLUSTRATIONS: MICHAEL CARROLL

Many researchers, including McKay, think odds are good that life may have had a chance to evolve. Gilbert Levin, former chief scientist for one of the life-detection experiments aboard the Mars Viking probe, believes there is evidence that traces of microbial life survive on the planet even today.

McKay worries that the human presence required to bring about the changes, and any colonization that might follow, could introduce terrestrial organisms that would drive the Martian microbes to extinction. Many species have been driven to extinction on earth by human actions. The notion of exterminating the entire living population of a planet, however limited that population might be, would certainly be a new threshold for humanity to cross.

Thus, McKay argues that existing life on Mars should preclude any human settlement of the planet, since its scientific and ethical value would be far too great to sacrifice. But he thinks that the presence of life should not preclude terraforming: since life probably evolved in an environment similar to the one humanity would create, the change may well allow it to thrive once again.

Zubrin takes the opposite view. Life or no life, he says, humanity's destiny is to explore and expand, and Mars is far too desirable a potential home for our species to be left alone just for the sake of a few primitive microbes. These should be studied and preserved as much as possible, he argues, but should not stop our exploration and transformation of their home planet.

McKay is currently developing experiments for future Mars probes, including one to be carried on Russia's Mars '94 probe that will test the Martian soil for past life. He is also devising methods of searching for fossil remains. Beyond that, until human exploration of Mars becomes a national or global priority, he is planning to study microbial life that has remained dormant for millions of years inside the Siberian and Antarctic permafrost. Martian microbes, he speculates, may have done the same.

—*DAVID L. CHANDLER*

A Whale of a Mission for the U.S. Navy

To study whales, researchers usually have to travel by boat or plane to search for the elusive giants and then, if they are lucky enough to encounter any, quickly gather data before the whales disappear into the depths. But now whale biologists have access to a system that will enable them to track whales across entire oceans without ever leaving shore.

The tracking technology, known as the Integrated Undersea Surveillance System, is actually a string of U.S. Navy listening devices planted on the sea floor after World War II to eavesdrop on Soviet submarines. Following a recent congressional mandate to seek peaceful uses for military technology, the Navy, which had been picking up strange whale calls for years with the hydrophone array, invited cetologist Christopher Clark, director of Cornell University's Bioacoustics Research Program, to work with the equipment at the Naval Research Lab in Washington, D.C. Clark, who had long been itching to use the undersea listening devices in his research, was given a grant from the Office of Naval Research to demonstrate how they could be used to study the mysterious mammals.

One of the Navy's goals, says project manager Commander J. Dale Liechty, is to develop a "data set to show us where the whales are so we don't bother them with our exercises." The other motivation, he explains, is that with the end of the Cold War, using the undersea network to hunt whales "maintains the skills of our operators and prevents degradation of the equipment."

"Within the project's first couple of days, we had gathered more new data than most of us had ever hoped to see in a lifetime," says Clark. One hour of listening to a blue whale, for example, produced more sounds than had previously been recorded in the literature. And the researchers made some 35,000 whale contacts during the first three months—more than had ever been detected in the U.S. whale census studies.

Christopher Clark of Cornell's Bioacoustics Lab analyzes sonograms of whale songs recorded by U.S. Navy undersea microphones once used to eavesdrop on Soviet submarines.

Like a squadron of sharp-eared spies, several arrays of hydrophones in the Atlantic and Pacific—the exact number and location remain classified—record whatever sounds permeate the cold, sightless depths. Twenty-four hours a day, 365 days a year, they transmit the results of their surveillance to shore stations, where Navy analysts apply various signal-processing techniques to the data for visual display. Like birders in an impenetrable forest, the technicians then strive to identify each sound.

"The output is like specialized sheet music, and the Navy technicians are the musicians," says Clyde Nishimura, a geophysicist at the Naval Research Lab, who likens the deciphering process to his attempts to puzzle through notes at seventh-grade band practice. Before helping Clark, he had been using the array to study t-phases, the acoustic signatures from underwater earthquakes. But he admits the tubalike calls of the lonely leviathans have enticed him into spending more time interpreting their talk than he had planned.

Some in the Navy grumble that such studies are more than they planned for as well. Skeptics argue that the Navy's mission is not to track whales, says

PHOTO: SHARRON BENNETT

Clark, but to defend the nation, and that the budget has no room for such work. Fortunately for whale biologists, these detractors could not argue with a militarywide order to seek alternative uses for defense systems that has recently turned several former U.S. military bases into nature reserves. The order also prompted the Navy to send five scientists to the Arctic aboard one of its nuclear attack submarines to study the polar ice cap, the first nonclassified work on such a vessel.

The Navy analysts themselves showed no such aversion to their revised mission. One of the technicians, Lieutenant Charles Gagnon, even hooked up his son's boom box and played out the distant whale calls as they came in, to the delight of visiting Navy officers.

The arrays may provide answers about how many whales of each species exist. So far, Clark says he can accurately detect four species in the Atlantic: blues, fins, humpbacks—all endangered—and the minke, whose world stocks, argue Norway and Japan, are robust enough to permit commercial whaling.

Sound Reckoning

The system is also enabling the research team to plumb the secrets of whale behavior. For example, Clark tailed the signature call of a blue whale for 43 days as it made a bee-line from Cape Cod to Bermuda. Clark surmises that it navigated by bouncing low-frequency sounds off the Bermuda coastline, emitting pulses every 10 minutes for hours on end.

In the same way that dolphins use high-frequency clicks, whales may be using the low-frequency calls to construct a mental image of their dark, fathomless world, says Nishimura. They may also use their voices to glean evidence of variances in ocean fronts, the plankton-rich boundaries between warm and cold waters that promise good feeding grounds.

"These animals have been out there for 30 to 40 million years, they have large brains, they live a long time, and they haven't been relying on their eyes to get from one place to another or to find food," explains Clark. "I think they've long ago discovered these tricks that we're only just learning how to do, in not very efficient ways."

One such trick may be using the ocean as a natural telephone to converse over staggering distances. In the early 1970s, marine biologists Roger Payne of Rockefeller University and Douglas Webb of Woods Hole Oceanographic Institution published a paper theorizing that whales, long recognized as extremely sociable creatures, could communicate over hundreds or thousands of miles to locate one another or assemble the herd.

"It was so wild an idea that most people ignored it," says Clark. "But it's pretty clear to me now that they were right." Based on the Navy data, Clark thinks that whales can communicate over entire ocean basins. Under ideal conditions, he has found, a humpback off Newfoundland can exchange calls with another in the West Indies.

Clark believes there is much yet to decipher from the data. "It's like being dropped into a room with all these conversations you've never heard before and trying to make sense of them," says Clark. "I can look at a bunch of whales and ask, 'How does Joe sound compared to Ulysses? Do they have different voice signatures? How do whales behave if they're from the Norwegian Sea as opposed to the Caribbean? Do they have different dialects?'"

Such basic research questions quickly suggest applied queries. How does acoustic pollution from ships, ocean drilling, and submarine sonar interfere with whales' ability to communicate? And how will the new sound-emitting instruments—some as loud as a jet plane taking off—now coming online to monitor ocean warming adversely affect whales?

To address such questions, Clark is seeking additional funding from the Office of Naval Research as well as from a host of other federal agencies involved in marine mammal research, including the National Science Foundation and the National Oceanic and Atmospheric Administration.—*PETER TYSON*

PHOTO: STEPHEN LANSING

Growing Rice the Old-Fashioned Way, with Computer Assist

For more than a millennium, Bali, an island in the Indonesian archipelago, had one of the most successful agricultural systems the world has ever known. The island's farmers harvested several tons of rice from every acre of their terraced fields year after year without ecological deterioration. But when Indonesia turned to the modern technology of the Green Revolution in the 1970s to feed its burgeoning population—which had become the fourth largest in the world—Bali's delicate system nearly collapsed.

Following reports that scientists had prevented severe famine in India, South America, and southeast Asia with newly developed strains of fast-growing, high-yielding rice, the Indonesian government imported agricultural experts from Western countries to implement contemporary growing practices throughout the country's rice-growing regions. In Bali, the provincial government ordered farmers to abandon their long-standing practice of carefully timing planting and fallow cycles and instead plant fast-maturing rice as quickly and frequently as they could. They were also instructed to blanket the new crops with tons of fertilizers and chemical pesticides, which they

A student works with a Balinese water temple priest, who advises local farmers, on a computer model that adapts age-old irrigation methods for use with new, fast-growing varieties of rice.

could buy at subsidized prices.

Reports from the island's agricultural offices soon spoke of "chaos in the water scheduling system" and "explosions of pest populations." By the mid-1980s, the paddies of Bali were being infested with one pest or virus after another, despite attempts by agricultural experts to develop resistant strains. Rice production plummeted.

During the late-1980s, anthropologist Stephen Lansing, now chair of the Department of Anthropology at the University of Southern California (USC), was studying the historical evolution of the island's rice temples, whose priests had dictated the planting schedules. But instead of talking about legends, farmers told Lansing how their crops were failing since the temples had lost control of the rotational irrigation schedule for the fields in their vicinity under the new farming policy.

Although Balinese farmers had known for centuries who controlled the agricultural system, it was not understood by the outside world or even the Balinese bureaucrats responsible for the island's agriculture. So with a grant from the National Science Foundation, Lansing began the long process of unraveling the details of the system.

Lansing discovered that it was tied together by rituals managed by priests at the Temple of the Crater Lake, high in the mountains—the source of the island's water. He learned that the temple priests had devised an intricately balanced system that coordinated the release of water from rivers to groups of

cooperative farms through a system of weirs and tunnels. After a paddy was flooded and planted, the growing rice became a source of food but also a breeding ground for pests. If one crop was planted immediately after another, the pests multiplied out of control and devoured an entire crop. So the priests incorporated fallow cycles throughout the farms so that the pests died off from a lack of food.

The fallow times were also part of the cycle of natural fertilization. After the rice was cut, the stalks were left to disintegrate in the flooded paddies. Ducks were herded into paddies to eat insects and fertilize the soil. Blue-green algae bloomed and added nitrogen to the soil. When the pests died, a new cycle of planting began.

In 1990, when Lansing first tried to explain the importance of the rice temples to experts at the Asian Development Bank, which had imposed an irrigation schedule to match the short growing cycles of the new strains of rice, he was paid little attention. It was not until the next year, when he and USC ecologist James Kremer developed a computer model to define the problem and offer a solution, that the bank's experts began to listen.

Lansing and Kremer used their computer model to analyze seven possible management systems, which ranged from having all farms follow the same cropping pattern to having all follow different schedules. The model calculated the harvest for the farms by taking into account the flow of rivers based on rainfall by season and elevation, the different varieties of rice, and the population dynamics of pests.

The program quickly illustrated the dilemma: if all farmers plant and let their fields go fallow at the same time, then infestation of pests decreases, but the demand for water overwhelms the supply, especially during the dry season. However, if they all plant their crops at different times, they may have enough water but are overwhelmed by pests.

The results also showed that the procedures imposed by the outside agricultural experts were doomed to failure. When all farms plant and harvest rapidly and independently, up to 100 percent crop loss occurs from pest infestation, regardless of whether the crop is traditional long-cycle Bali rice or the fast-growing Green Revolution rice.

The system that resulted in the highest yields with the fewest pests and most efficient use of water was virtually identical to that employed by the rice-temple priests. The trick, the researchers found, is to coordinate planting cycles around water availability at the high elevations, where smaller rivers supply significantly less water, and around pest infestations at the low elevations, where water is abundant from the larger rivers, but natural barriers to pests, such as deep valleys and ravines, are few. In the highlands, farmers carefully stagger planting so that everyone has a steady supply of water. In the lowlands, farmers irrigate large tracts at the same time but delineate the fields carefully to provide barriers when they lie fallow.

Allowing wide tracts of rice paddies to lie brown and fallow effectively rations scarce water supplies and provides natural insect barriers between lush irrigated fields.

In the lowlands, where the rivers are larger, farmers can plant almost year round, except during the driest periods, and still ensure enough water for the rest of the island. But with fewer natural barriers, the farmers must coordinate the fallow periods to minimize pest damage.

Today, the Asian Development Bank has admitted its error. And the rice-temple system in Bali, whose colorful ceremonies were never abandoned by farmers, is being reestablished.

Lansing and several colleagues are now working with Indonesia's agricultural officials on a project funded by the U.N. Food and Agricultural Organization to adapt the computer program to meld the new rapidly growing rice varieties with the old system. One major problem farmers face is that Green Revolution rice hybrids cannot be grown without fertilizers, which threaten to upset the basic ecology of the rice paddies. At present, farmers apply the chemicals without knowing how much they really need in a system that has been self-fertilizing for centuries. But because farmers in different areas use different amounts of fertilizer and record how much they use, extension agents are amassing enough data to help farmers determine how to reduce usage to absolute minimum levels and still maintain high crop yields.

The computer program may also help Bali farmers face their next challenge, says Lansing. Tourism has recently edged out agriculture as Bali's leading income producer. Mushrooming luxury-hotel complexes on the island's southern tip are drawing alarming amounts of water from the same rivers that supply the irrigation system. If the situation escalates, he says, agriculture will lose, and Bali's social fabric may begin to crumble.

Lansing wants to prevent a showdown between agriculture and tourism by using the computer analysis to work out a better water-distribution system. The program can pinpoint rivers and irrigation systems with an abundance of water from which engineers can draw for new development. At present, they are unwisely drawing water from the closest watershed, which is already showing signs of stress.

—*JANE E. STEVENS*

PHOTO: STEPHEN LANSING

Sperm Busters

While women are able to choose from a variety of contraceptive options, men have just two realistic choices besides abstinence: condoms, which aren't that reliable, and vasectomy, which isn't that reversible.

This disparity between the sexes is largely due to a biological reality, says Nancy Alexander, chief of contraceptive development at the National Institute of Child Health and Human Development. "Turning off the continuous production of 200 million sperm per day presents tougher problems than stopping the development of one egg a month."

But researchers have recently made strides that may someday enable men to more effectively share the responsibility of birth control. Avenues of research range from a silicone plug that blocks sperm from rushing out of the vas deferens during ejaculation, to a powerful steroidlike chemical extracted from cottonseed that has been called a "medical vasectomy," since it almost irreversibly renders men infertile.

But the most promising approach appears to be in manipulating hormones to temporarily inhibit fertility. Some of the early work in this area was conducted by Spyros Pavlou, associate professor of obstetrics and gynecology at Harvard Medical School, who studied 10 volunteers who gave themselves daily injections of a substance called Nal-Glu (shorthand for a long and complex chemical formula). This tiny protein clogs up all the pituitary gland's receptors for naturally occurring gonadotropin-releasing hormone, or GnRH. In the absence of a signal from GnRH, the pituitary stops making two other hormones that travel through the bloodstream and ultimately stimulate the testes. Without these two—luteinizing hormone and follicle-stimulating hormone—the sperm-making machinery

ILLUSTRATION: SCOTT GLAZIER

quickly grinds to a halt.

Within 6 to 14 weeks, all but one man using Pavlou's demanding and painful technique reached a condition known as azöospermia, meaning that the fluid they ejaculated contained no sperm. (The tenth man dropped out of the study because the daily injections caused painful local inflammation.) Similar studies in Seattle and Los Angeles produced the same results and indicated that both sperm production and fertility returned within a few months once the injections of Nal-Glu were discontinued.

The downside was that the injections also halted testosterone secretion. Without this hormone, the sex drive fades, erections fail, hot flashes similar to those experienced by women in menopause appear, and osteoporosis starts to weaken bones. To counter these effects, the volunteers injected synthetic testosterone into the thigh muscle weekly.

It is unlikely that even motivated men would put up with this dual-injection technique. But as Pavlou points out, this initial work was done just to "prove the concept" of suppressing fertility with hormones. And researchers have since been turning their attention to simpler, long-term delivery methods for testosterone and the hormone antagonist.

For example, UCLA scientists have put highly concentrated testosterone into time-release microspheres that need be implanted under the skin only once every three months. These scientists are also developing implants of concentrated GnRH antagonist and testosterone that they hope will work for a full year or longer. Effectiveness may actually be enhanced with this approach: the implants release the substances gradually, keeping serum levels more constant than is possible with injections.

Still, such antagonist-plus-testosterone implants are 7 to 10 years away from the market, even if all the clinical trials go well, predicts Pavlou. That's due partly to stringent requirements by the Food and Drug Administration for testing new products, he says, and partly to the lack of research money. In fact, virtually all such work has been government funded, as the number of U.S. pharmaceutical firms pursuing contraceptive research has dwindled to one. Ortho Pharmaceuticals is the sole survivor among 17 drug companies that were in the contraceptive business a decade ago—the others dropped out for fear of liability.

One approach that may speed the development of a hormonal contraceptive for men is to simply give high doses of testosterone. Researchers point out that because this hormone is produced naturally by the body, unlike the GnRH antagonist, a testosterone-only implant may not have to jump as many regulatory hurdles at the FDA and therefore could be available in less than five years.

To test this theory, researchers at 11 World Health Organization (WHO) centers around the world are giving 350 men weekly injections of testosterone, increasing levels to 50 percent above normal. To counteract this boost, the pituitary gland stops producing both follicle-stimulating and luteinizing hormones, which in turn switches off sperm production. After several months of testosterone injections, 50 to 60 percent of Caucasian men, and 90 to 100 percent of Asian men, had sperm-less ejaculations. This unexplained finding is prompting further study.

The efficacy of this method may be even more dramatic than the numbers indicate since it may not be necessary to completely shut down sperm production, says William Bremner, director of the University of Washington's Population Research Center. In fact, the WHO is now following testosterone-taking men whose sperm counts dropped significantly but never reached zero. Preliminary results indicate that their fertility rate is one pregnancy per 100 couples per year, which is three to six times better than the fertility rate of couples who use condoms.

—P.J. SKERRETT

Nuclear Reactors: The High Cost of Early Retirement

With the well-publicized shutdown of a half-dozen nuclear plants in the past few years and some two dozen more of the nation's 107 plants due for closure within the next decade, the issue of disposing of the plants' spent nuclear fuel and radioactive reactor components is itself reaching critical mass.

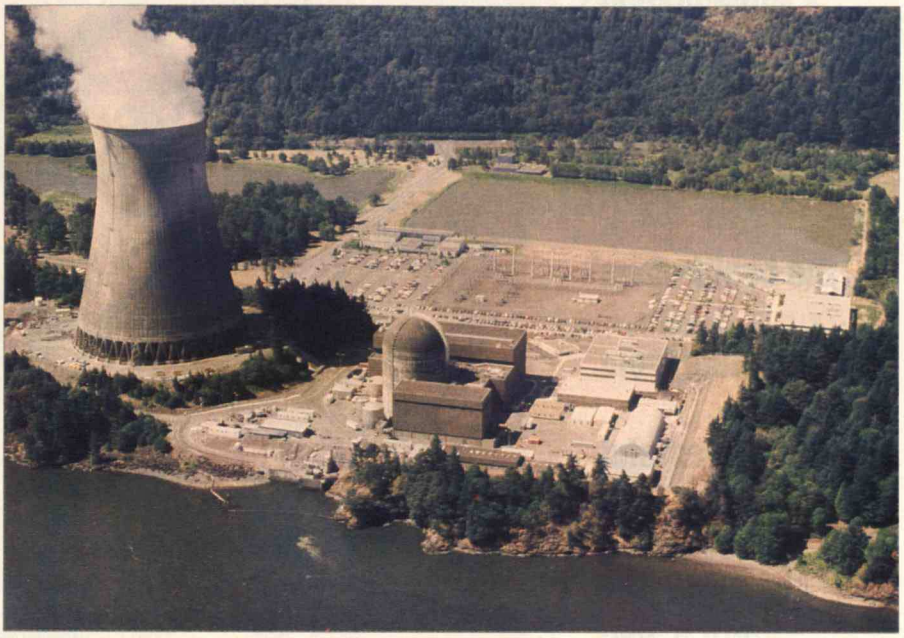
Oregon's Trojan reactor serves as a case in point. Last spring, in what they termed a "gut-wrenching decision," officials at Portland General Electric Co. voted to shut the large 1,100-megawatt plant permanently after 17 years of operation. Repeated maintenance problems had earned Trojan one of the worst reliability records in the nuclear industry, and Kenneth Harrison, CEO of the utility, explained that it was simply "not prudent to spend more money to maintain Trojan."

Unfortunately, the company now realizes, it will be forced to spend a great deal of money anyway. The plant's economic viability—like that of all other reactors—was predicated on a 40-year life span. And while Portland General regularly set aside funds during the Trojan's operating life toward its eventual demolition, as required by federal regulations, the utility managed to accrue only $40 million for a task that is now estimated to cost some $488 million.

Few Disposal Options

Portland's utility will not be the only one facing such huge disparities in closing costs. A report issued last fall by the Congressional Office of Technology Assessment (OTA) predicted that the "early retirement" of dozens of aging and uneconomic nuclear reactors "may result in substantial underfunding of decommissioning accounts."

Moreover, a Rand Corp. report on decommissioning notes that costs have



Like dozens of nuclear facilities being forced by high maintenance costs to close early, the Trojan power plant near Portland, Ore. is ill-prepared to dispose of its radioactive waste.

likely been underestimated, especially since the long-espoused 40-year life span for nuclear reactors has proven unrealistic. Some of the plant's most costly components are guaranteed for only 15 years or less, and the average age of the reactors shut down thus far is roughly 13 years.

All told, Geoffrey Rothwell, an economist at Stanford University, believes it will ultimately require as much as $33 billion to shut down all of the nation's nuclear power plants during the next several decades.

But concerns over unexpected costs pale beside the technical issues of how to dispose of the radioactive materials, says Rothwell. At present, there is nowhere to permanently dispose of the used fuel rods, which sit temporarily in cooling pools at reactor sites. These pools, many already filled to capacity, were never designed for long-term storage and as such may pose safety risks.

The Department of Energy's proposed permanent repository for high-level radioactive waste, a planned tunnel system dug into Nevada's Yucca Mountain, has been plagued by delays. In fact, the state of Nevada has halted research on this site for three years and threatens to fight the radioactive dump until the end. At best, the Energy Department now says, Yucca Mountain will not be ready to accept waste until the year 2010.

In the meantime, federal legislation requires the government to assume responsibility for the nation's high-level waste in January 1998, storing it at a temporary facility until a permanent repository is completed. Yet even this plan has yet to materialize.

Even if the disposal quandary for the highly radioactive spent fuel is resolved, a far greater quantity of radioactive waste—a nuclear reactor's components, comprising at least 15 percent of all the material used in its construction—would also have to be secured. This radioactive debris, including steel-walled reactor cores, concrete foundations, metal piping, and valves, averages some 160,000 cubic feet, or enough to cover a football field about 5 feet deep.

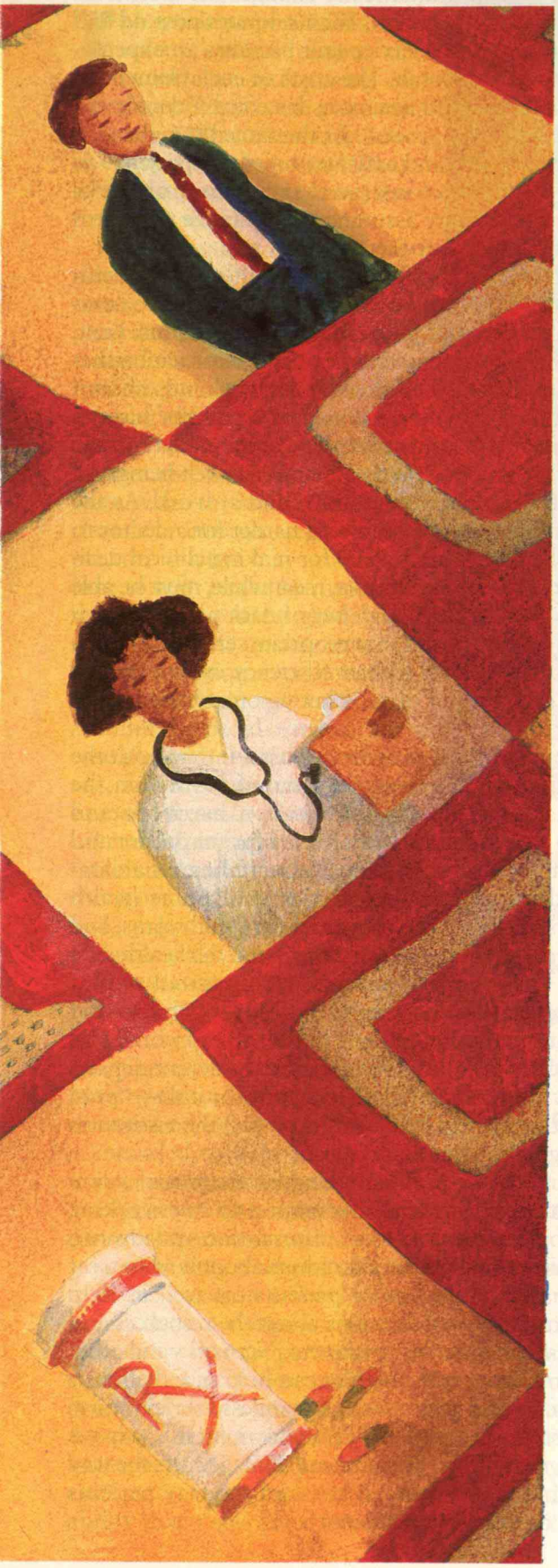
The disposal options for low-level nuclear debris are almost as limited as those for high-level waste. Of the nation's three existing facilities, only the one in Barnwell, S.C., is still accepting out-of-state radioactive waste and it, too, is scheduled to close permanently in a year. While new facilities are planned, none is yet open, and most have so far been stalled by local opposition. Meanwhile, communities with now-closed reactors face the prospect of watching these shuttered plants remain idle with skeleton staffs responsible for maintaining safety indefinitely.

A recent change in the regulations that govern decommissioning funds offers one bright note. Because utilities can now invest these multimillion-dollar holdings any way they wish (previously they could only invest in government bonds), they are expected to increase annual earnings from roughly 5 to 10 percent.

While this liberalized policy offers communities with closing reactors little consolation in the near term, and the political crisis may well fester, the economic picture for utilities will likely improve. "The longer the utilities wait," says Rothwell, "the more money they'll have to do the job."—*SETH SHULMAN*

PHOTO: PORTLAND GENERAL ELECTRIC

Information technology can help transform the health-care system from a wasteful colossus into a lean and effective enterprise.



Plugged-In Medicine

BY JEROME H. GROSSMAN

WHEN one thinks of technology in health care, the first things that usually come to mind are medical advances: gene therapy, laser surgery, diagnostic imaging, and the like. Indeed, this is where we have put our greatest efforts in the post-World War II era of biomedical science. But a different kind of health-care technology, less flashy and less likely to make headlines, has been emerging over the past decade, and may soon equal or surpass high-tech therapies in importance. These are technologies for improving and managing the "production" process of health care. They include clinical decision-making systems, advanced information and management-support systems, and multimedia communications networks. Together they may be regarded as the tools to reengineer medical

ILLUSTRATIONS: KEVIN HAWKES

practice: all are designed to help the health-care system perform better by providing improved care at lower costs.

The rise of health-care management technology mirrors the shift in priorities that is gradually taking place in the medical community. As the public debate over health-care reform has made clear, providers have put too much emphasis on inputs and too little emphasis on outputs, or "outcomes." That is, we have mistakenly focused on delivering more and better tests and procedures instead of on improving the health, well-being, and satisfaction of patients.

Under the old way of thinking, providers have not been paid to maintain or restore health; we have been paid to dispense units of service. If the price of lab tests and medications goes up, patients are charged more, regardless of whether there is a better end product. In traditional fee-for-service payment plans, we have been rewarded for making the greatest use of inputs, regardless of their effect on the patient's condition. The more we do, the more we earn. Accordingly, we have steadily improved the clinical tools at our disposal for diagnosing and treating disease. Yet we have paid much less attention to the bigger picture: how to produce the best outcomes for the patient as efficiently as possible. Progress toward this goal has not even been measured, let alone rewarded.

Over the past decade, several developments have moved us toward a new way of thinking. The marketplace, spurred on by large employers and governmental payers, has begun demanding value by purchasing health care more selectively and by trying to define and measure quality. Managed-care plans like health maintenance organizations, which pay providers a set amount to care for a certain population for a certain period of time, have proliferated. In 1983, Medicare introduced a payment system in which it gives hospitals a single, predetermined sum for each admission, according to the patient's diagnosis-related group (DRG). As a result of these changes, providers have begun devoting more attention to the efficiency and effectiveness of the care they dispense.

Under this new way of thinking, the service that medicine provides is integrated health care rather than discrete units of things done for patients. Depending on the patient's needs, that integrated service might take the form of routine health maintenance, treatment of an illness or injury, or management of a chronic disease. Providers and payers set price levels for these packages that reflect our best knowledge of their reasonable costs, and except in unique cases providers must live within these established revenue limits.

Such a system dramatically changes the incentives within the delivery system. With revenues prepaid and predetermined, each service unit becomes an expense, not a source of income. The costs of each element of care must be weighed against its benefits to identify the most cost-effective process. At the same time, the outcome—the health and satisfaction of the patient—is measured and monitored, so that cost control works together with quality assurance to minimize the incentive to underutilize services.

As doctors and institutions pursue this vision of efficient health care based on outcomes, we run into complexities that cry out for technological solutions. First, there is the tremendous volume of new information that must be processed. The already overwhelming amount of data a physician must assimilate on patients' history, condition, and treatment is being compounded by new layers of information on their emotional well-being and how well they function at home and at work. As the variables multiply, it is becoming harder for a doctor to know which ones are critical for making clinical decisions. Hospital administrators, meanwhile, must be able to track and organize a welter of data to distinguish between necessary and inappropriate services, to identify opportunities for greater efficiency, and to project the cost implications of substituting one form of treatment for another.

At the same time, providers must contend with the high degree of fragmentation that exists within the health-care system. Communication barriers stand between the various provider units (primary care and specialist physicians, hospitals, laboratories, rehabilitation and nursing home facilities, and home health providers); between the providers, the health plans, and the payers; and between the patient and the health-care system. These barriers need to be minimized so that caregivers can consult together effectively, and so that information about a patient can reach everyone who should know as quickly as possible. Different departments within a hospital also need to be able to pool information to help document how well the institution is serving its patients and payers.

To relieve these problems, health-care providers are turning to sophisticated information and networking technologies. Computerized information systems can help clinicians make better decisions about how to treat individuals and groups of patients, as well as help administrators make decisions about the resources and processes that affect that treatment. Networks and other communications technologies can help fuse the many components and players into a seamless fabric of care. Such systems are gradually transforming the way we practice, the way we organize and manage care, the way providers relate to each other, and the way patients relate to the medical community.

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Consulting Computers

The work of physicians involves endless testing of hypotheses and posing of questions: What is the patient's diagnosis? What test should I do to confirm the diagnosis? What is the best treatment? How is the treatment working?

In arriving at a decision and recommendation, physicians of course rely on their own judgment and experience, on the relevant literature, and on established clinical guidelines for treating different types of patients. But valuable as these resources are, there are still occasions when the answers are not clear. In an emergency, for example, the doctor may not have time to refer to the literature or search for the latest guideline. And the clinical guidelines for a certain condition, even if readily available, might not take into account the peculiarities of the case at hand: the patient's age, sex, and race; the stage of disease; the presence of other medical conditions; and special risk factors like allergies. An error can prove costly, both in dollars and, more important, in the patient's health and survival.

Physicians at my hospital, New England Medical Center, are working on two types of computer-assisted "decision support" techniques for just such circumstances. One approach is intended to help physicians make accurate diagnoses in emergencies. The other will help determine the best course of treatment for individuals or groups.

In addressing emergency decision making, our goal is to develop accurate and easy-to-use instruments that can isolate the most important variables and calculate the probability that the patient is or is not going through a crisis that calls for some specified action. One such device developed by our researchers and now in trial use is the Acute Cardiac Ischemia Time-Insensitive Predictive Instrument. ACI-TIPI (pronounced "A.C.I.-tippy") helps emergency-room physicians quickly determine the probability that a suspected heart attack is real. A correct diagnosis is of paramount importance, both medically and economically. Each year, 1.5 million patients are admitted to coronary-care units, yet fewer than half are actually experiencing, or about to experience, a heart attack. These unnecessary admissions cost over $3 billion a year. More costly in lives is the opposite sort of mistake: some 20,000 heart attack victims each year are sent home from emergency rooms without treatment.

The already overwhelming amount of clinical data a physician must assimilate is being compounded by new layers of information on patients' emotional well-being and occupational fitness.

In the emergency room, an electrocardiograph is outfitted with a special ACI-TIPI computer program. The physician enters a few items of information, such as the patient's age and gender and whether chest pain is the chief complaint, and generates an electrocardiogram (EKG). The program analyzes these factors along with three EKG-related features, and then computes the probability—from 0 to 100 percent—that the patient is suffering from acute cardiac ischemia (a severe reduction of blood flow to the heart) and prints it on the EKG. The entire procedure can be completed within minutes of the patient's arrival, instead of the several hours it takes to perform a blood test that can confirm a heart attack. That time difference can be critical.

A two-year study of an ACI-TIPI prototype found that its use reduced unnecessary coronary-care admissions by 30 percent. Projected to every U.S. hospital, that figure would translate into 250,000 fewer admissions each year, as well as a saving of perhaps $1 billion in unnecessary health-care costs. The latest version of ACI-TIPI, which is easier to use than the prototype, is now undergoing clinical trials on some 15,000 patients at 10 hospitals around the country.

For non-emergency care, researchers at New England Medical Center are collaborating with MIT's Laboratory of Computer Science to develop computerized "expert systems" that help doctors make the most sensible treatment decisions in complex cases. Some of

these tools quantify the risks and benefits—both clinical and economic—of different strategies for treating a given condition. They are proving useful for resolving dilemmas in treating coronary artery disease and diabetes, performing heart transplants, diagnosing prenatal and neonatal conditions, and other situations. These systems offer physicians choices in the form of a "decision tree," allowing them to see the possible ramifications of each step: If a patient receives surgery instead of medication, what is the probability that complications will set in? If the complications are treated with drugs, what is the probability that the patient will live? If the patient lives, what is the probability that he or she will suffer from a chronic impairment? And so on.

Such decision trees can be tailored to include a patient's individual preferences and risk factors such as age, sex, and the presence of secondary conditions. For example, a decision tree we developed in collaboration with Duke University examines the choice among bypass surgery, less intensive angioplasty, and medical therapy for chronic stable angina. Such models might take into account that the patient would rather live with some pain than receive a treatment that carried a risk of stroke. Other models being developed jointly at New England Medical Center and MIT are designed to help physicians predict a patient's response to drugs.

The Plugged-In Physician

Beyond helping doctors make decisions in unique or difficult situations, information technology can serve as an invaluable aid to physicians in routine practice. In particular, the automated collection, analysis, and transmission of data allows doctors to get the information they need when they need it. The result is better clinical care, more efficient and patient-friendly service, and higher job satisfaction for caregivers.

The physician stands at the center of a swirl of information—from patients, from labs and radiology departments, from specialists. Today, most transactions in health care do not exist in any computerized system, and the systems that do contain such information are not integrated. But in the emerging computerized health-care environment, information from one office or lab can be flagged and delivered to another office or lab according to rules and criteria that the users themselves have written.

In the traditional, nonintegrated environment, test results remain in a lab's computer until a batched group is transmitted to another computer, or else individual results are manually flagged and reported by phone or fax, whereupon the message waits until the physician can be found. The latest "intelligent message routing" systems offer physicians a menu of rules and options: which results should be routinely transmitted, what kinds of readings warrant an immediate notification, where else results should be sent. If a test result is required before a patient can be discharged, for example, a doctor might order that this information be phoned in immediately and that a specialist receive a copy. The intelligent message routing system screens lab transactions, flags the ones meeting the defined rules, and transmits information to the requested parties, whether by electronic mail, fax, or paging device. The rules can also require that receipt of the information be acknowledged, or that the message be repeated at defined intervals.

For intelligent message routing to work on a large scale, the health-care system must become far more computerized. Just as important, systems in different locations must be able to communicate. Fortunately, we no longer need to rely on expensive proprietary solutions in which systems can be integrated only if the hospital works with a single vendor. The trend toward open, nonproprietary standards—such as Simple Mail Transport Protocol and Dynamic Data Exchange—allows us to create software that integrates bits and pieces of the health-care operation as needed.

Managing the Process of Care

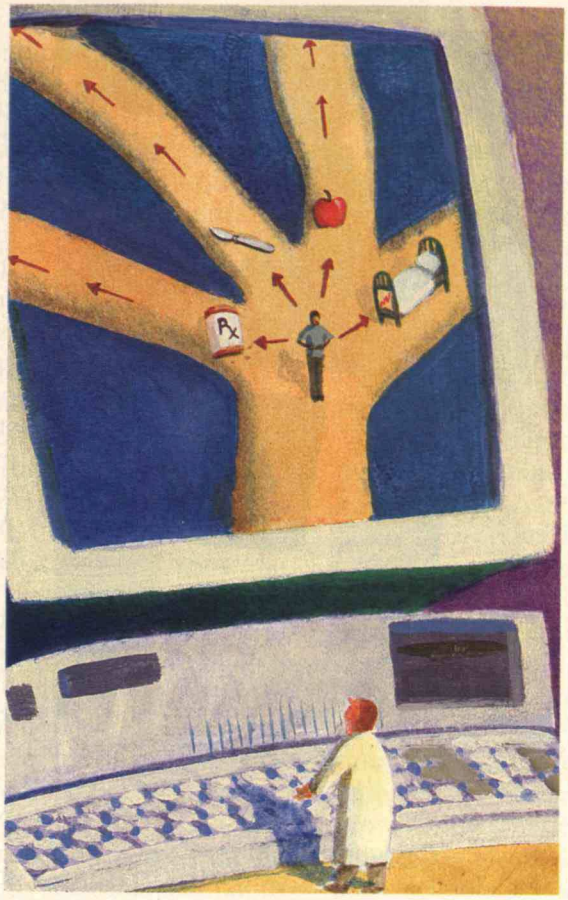
The new combination of rules-based technology and standard interfaces between systems can help hospitals monitor and improve the overall efficiency and effectiveness of the care they deliver. In the past, each component of a hospital information system—general ledger, payroll, billing, and medical records—would collect and report its own data. The new systems, in contrast, link these types of data together to show how each unit of service affects the overall cost and quality of care.

Since the 1980s, New England Medical Center has been using systems to analyze the course of treatment for different groups of patients. For example, we can lump together all the admissions for diabetes and track these patients' care: length of stay, tests and procedures performed, costs, and clinical outcomes like readmissions. We can look at subsets of patients by age, other medical conditions, or physician. In the process, we might find that extra lab tests add no value, that one physician's patients tend to stay longer without any difference in outcomes, or that patients who received one medication did just as well as others who were given a more costly drug. This information is valuable for clinicians and managers alike.

More recently, we have applied rules-based processing to define ideal clinical protocols that providers should be following. The protocols may govern the overall process of care—for example, what should be done to a certain type of patient on day one of hospitalization, day two, day three, on through discharge. Or they can govern specific components of care—recommending, say, that antibiotics not be used for more than two days after surgery unless an infection is diagnosed. We then write

rules telling the system to flag and report variations from these protocols, giving staff the opportunity to intervene. We can also monitor retrospectively how actual performance compared with the defined protocol, or how outcomes changed as a result of managing care according to the protocol. Armed with this information, we can alter our practices as appropriate.

One information system known as HELP (for "health evaluation through logical processing"), developed at Salt Lake City's Latter Day Saints Hospital, has been used to improve the way the hospital administers antibiotics. The system triggers reminders to give antibiotics to certain patients before surgery. Similarly, it issues automatic stop orders for patients who appear to have been left on antibiotic therapy too long, and notifies the pharmacist and the physician. When an infection is suspected but the agent is not known, the computer helps the physician choose the most effective antibiotic; using its own statistical analysis, HELP has selected the right antibiotic 94 percent of the time, a better rate than that achieved by physicians. The system also identifies cases where a less expensive antibiotic can be substituted for the one prescribed.



New computerized expert systems offer physicians choices in the form of a "decision tree," allowing them to see the ramifications of each possible treatment step.

In the future, we hope to incorporate a wider variety of data into these systems. A notable example is information on patients' emotional well-being and ability to function as reported in questionnaires at various points during and after the care process. This is a new and valuable measure of how well we are serving our patients. We also need to include data from settings other than the hospital—such as doctors' offices, labs, and outpatient clinics—in order to model and analyze the process of care across a full episode of illness. Over time we hope to integrate information from other institutions and from the research literature, so that users have more material from which to draw.

Tying It All Together

Just as integrating different sources of information can help institutions refine their practices, it can also reduce the fragmentation among the many players involved in a patient's care and treatment. The challenge is to bridge the barriers of space and time to meet the needs of individual patients and to make smooth and efficient processes routine. Our goal is a seamless healthcare system whose components work in harmony to respond to the needs of patients, regardless of where they happen to be within the system, and even if they are at home.

To a degree, the necessary bridges can be built with existing information technology. Intelligent message routing, for example, can be extended to include not just different units of a hospital but other organizations such as the payer or a nursing home. Referral forms from an internist can be delivered to the specialist and the managed care plan at the same time. And hospital reports on the eve of discharge can be electronically mailed to the recuperative facility or the home health agency that will follow the patient.

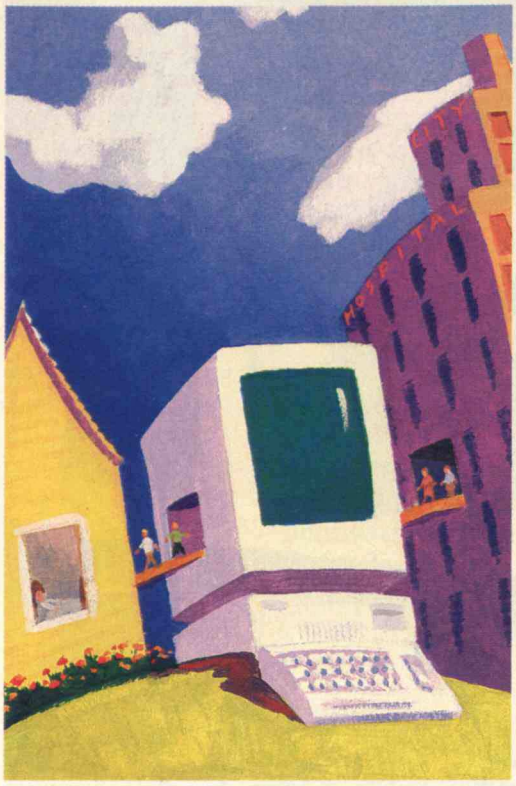
Transmitting information across sites is more difficult than within a single institution, but the necessary infrastructure is being built. One breakthrough that will affect all industrial fields, including health care, is the introduction of asynchronous transfer mode, or ATM, a switching technology that breaks digital transmissions down into small, standardized "cells," several of which can be processed at once. With ATM, vast amounts of data will be transmitted at higher speeds and lower costs than is now possible. Such advances not only will allow information to flow easily across distances but also will accommodate multimedia communications—the transmission of voice, data, still images, and video.

Using multimedia communications networks, doctors will be able to view clinical information and consult together anywhere, anytime. A physician in one location could participate in a patient exam, or even an operation, done by another physician someplace else.

Such networks will also connect facilities, making equipment at a teaching hospital available to a community hospital. A number of demonstration "telemedicine" systems, sponsored by telecommunications companies with the participation of health-care institutions and providers, are already in the works. Bell South's planned North Carolina Information Network, for example, will put rural clinics in touch with specialists at research hospitals, allowing them to communicate by voice and video and share computer data and graphics. With this sort of technology, we will be able to eliminate much of the physical movement of caregivers and patients that now takes place and at the same time improve the quality and cost-effectiveness of care.

The next step is to link the patient at home to the health-care system. Since the 1980s, institutions have attempted to contain costs by cutting down on inpatient care. But for patients with chronic illnesses requiring frequent medical attention, and no less for their families, managing at home can be a daunting task.

In 1991, New England Medical Center and IBM Research launched a joint effort to develop an interactive home-based computer support system for the care of children with leukemia. Prototypes are now being installed. The system is meant to serve as a user-friendly educational resource and to provide clinicians with progress reports directly from the patient. The unit incorporates videos showing how to change bandages or care for catheters, as well as videos of different families and caregivers discussing clinical and emotional aspects of the illness. The computer is connected to the hospital through electronic mail. The unit is easy to use, with touch screens and directories for gaining access to stored information on symptoms, technical aspects of care, or emotional and family issues. Planned for the future are an electronic patient-support network that will link patients who have similar conditions, a hospital-based bulletin system for news of important developments, and full-motion video transmissions between doctor and patient.



Computer support systems in the home will connect outpatients directly to the hospital, as well as to educational videos and other information sources.

This type of home interface provides numerous benefits. It gives families the information they need to participate in the care process more directly. It reduces the disruptions to family life by lowering the number of trips to the hospital or physician's office. It establishes a feedback loop between home and caregivers for monitoring the patient's physical and emotional state and compliance with the prescribed treatment, letting staff use their time more efficiently. And contrary to what one might expect, the technology actually humanizes care by addressing the emotional needs of the patient and family, and by easing the family's anxieties about tending to their ill member.

The link between the home-care patient and the caregiver will soon become even stronger: schemes are now under development for providing patients with instruments connected to a home computer that is in turn linked to an information network. If the patient needs regular electrocardiograms, a mobile machine at home would transmit the readings in real time to the EKG lab and the physician's office. A patient whose blood pressure must be monitored could insert one arm into a cuff attached to a computer, which would immediately read results into the medical record and flag any exceptional readings for the physician's urgent attention. Technologies like these will be a major step toward establishing the continuity of care that has eluded the medical profession for so long.

Overcoming Obstacles

Like virtually any effort to change institutions and ways of operating, the transformation of health care through information technology is encountering some obstacles. One is cost. For many hospitals and physician practices, sophisticated information and networking systems are simply too expensive. Fortunately, prices are coming down as the underlying technologies mature. Just as we can purchase high-powered personal computers today at prices that were unimaginable a

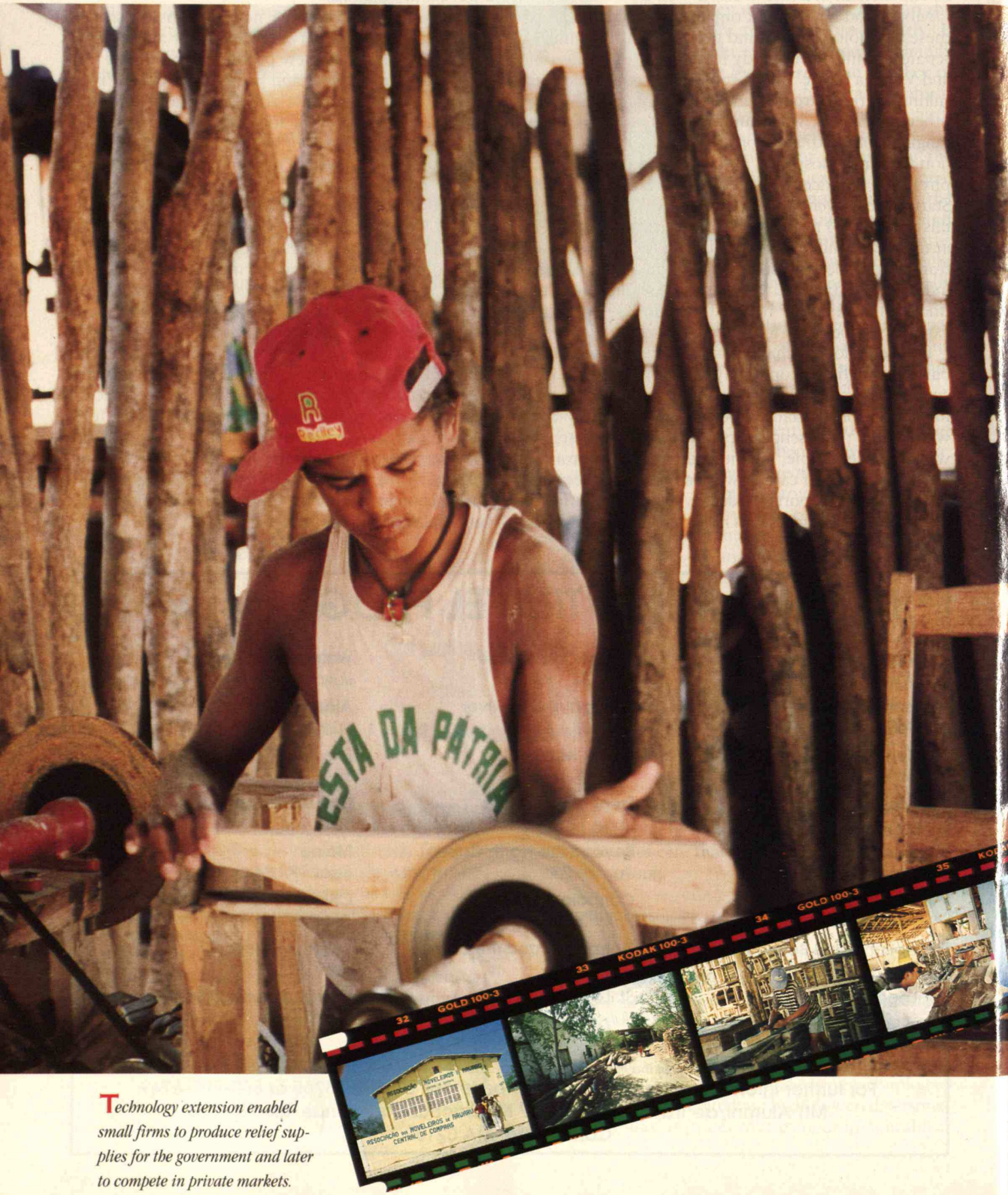
decade ago, information technology will continue to undergo an exponential increase in performance with an exponential decrease in costs.

More good news is that organizations able to afford these technologies will find their investment quickly repaid. In one recent study (conducted in Minnesota and Virginia by the Tiber Group, a Chicago-based consulting firm), electronic filing of health-care claims and other paperwork was found to yield annual savings ranging from $307,000 for small hospitals to $1.4 million for larger hospitals, and from $13,000 for small physician practices to $183,000 for larger practices. Start-up costs were only $11,000 to $12,000 for hospitals and $4,000 to $13,000 for medical practices. The authors concluded that conducting 85 percent of all transactions electronically would save the health-care industry $4.7 billion a year. As more studies show the financial benefits of new information systems, the expense will be easier to justify.

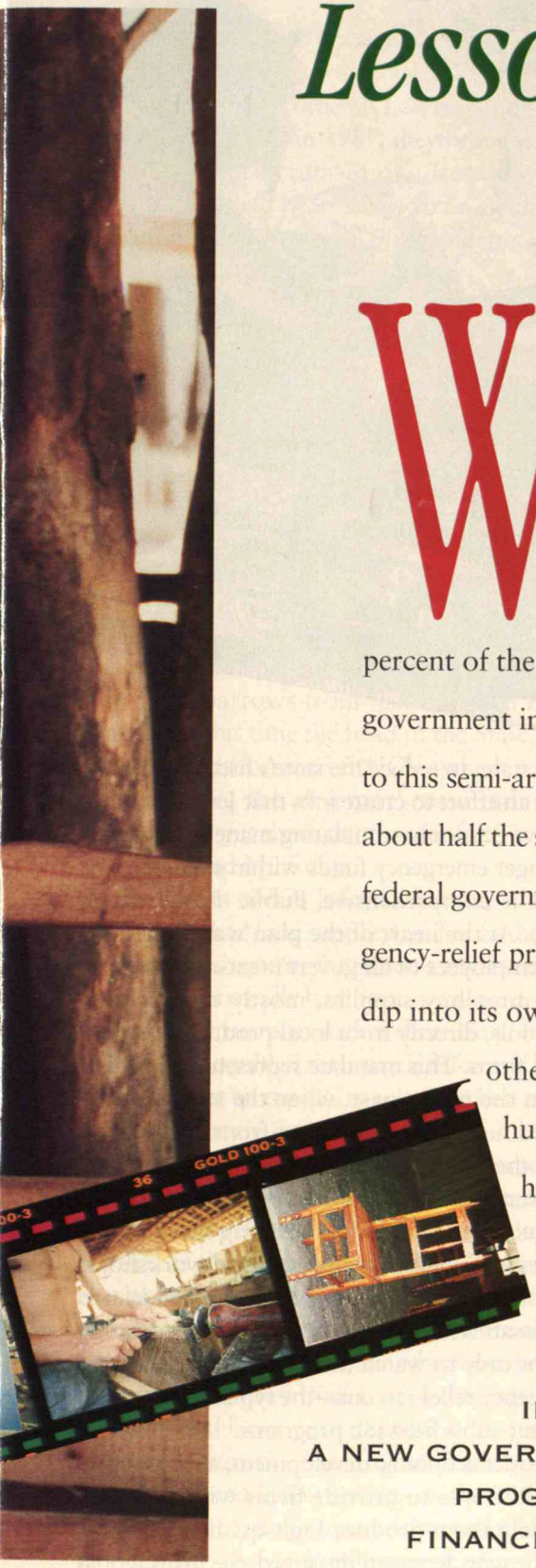
But technological change also runs up against human barriers. At first people may be intimidated by new computer systems, regardless of how user-friendly they may be. In some instances the new information systems will change the essence of people's jobs, for better or worse. For example, hospital staff who monitor the quality and cost of care now spend much of their time poring through reports to identify incidents that fail to meet specified criteria. With new systems that automatically flag variances, the staff occupy themselves with the more challenging task of analyzing the causes, effects, and solutions.

Designing and installing new systems must be a cooperative venture between developer and user. As much as possible, the new products should take into account the user's needs and habits. The ACI-TIPI system for identifying heart attacks, for example, was originally designed in the form of a calculator, which is not a standard part of the physician's "toolkit." Incorporating the system into an electrocardiograph made it more palatable.

In the past, the conservatism of the health-care community has caused it to lag behind other industries in applying information technology to help manage production processes. But now we must surge ahead. The Congressional Research Service has estimated that about half the growth in health-care expenditures is controllable—that is, unrelated to general inflation or population changes. As the emphasis in medicine shifts from inputs to outcomes, the incentives are growing for physicians to provide high-quality, cost-effective care. Advances in information and networking technology can accelerate this trend by helping care providers determine the most direct, most effective, and least costly means of diagnosing and treating patients. Such technologies offer the tools to redefine and restructure health care in our time. ■



Technology extension enabled small firms to produce relief supplies for the government and later to compete in private markets.



Lessons on Demand

BY MÔNICA ALVES AMORIM

WHEN Tasso Jereissati took office as the new governor of Ceará, Brazil, in 1987, he must have thought he was living a nightmare. Ceará—a state in the country's northeast region, where nearly half the population worked on farms—was paralyzed by a severe drought that destroyed the crops and livestock in 80 percent of the municipalities. During previous droughts, the Brazilian government intervened to provide food, water, and public-works jobs to this semi-arid state containing more than 6 million people in an area about half the size of Texas. But in 1987 no such aid was available, as the federal government, mired in a national recession, had eliminated emergency-relief programs. ❧ Caught in this double bind, Ceará had to dip into its own reserves to buy trucks, tractors, pipes, and a host of other supplies needed to provide water, food, and jobs to hundreds of thousands who had lost their means of livelihood. Unfortunately, Ceará was already one of Brazil's poorest states. More than half the employed population

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IN THE BACKWATERS OF BRAZIL, A NEW GOVERNOR'S UNORTHODOX PUBLIC PROCUREMENT PROGRAM TURNED A DROUGHT-INDUCED FINANCIAL CRISIS INTO AN OPPORTUNITY FOR SUSTAINED ECONOMIC GROWTH.

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PHOTOS BY CELSO DE OLIVEIRA E SILVA

Realizing that the production of quality goods was the key to the ultimate success of each firm, the government sent inspectors to the manufacturing sites to enforce strict standards.

was earning the minimum wage or less. The state's per capita GNP was less than half the national average. And although it is home to almost 5 percent of Brazil's population, Ceará was responsible for only 3 percent of the country's production.

To make matters worse, the state's finances and infrastructure were in disarray. Monthly tax revenues covered only 70 percent of the monthly payroll. And roads, schools, and hospitals were falling apart from lack of maintenance, as the previous government—a military dictatorship in which three federally appointed "colonels," usually wealthy landowners, ruled the state—had hired civil servants without competitive examination at the behest of powerful local politicians.

The new Ceará governor, a member of the Brazilian Democratic Movement Party and a former business magnate, decided to manage the crisis and the government as he would an ailing company—by enforcing efficiency and austerity. Jereissati started by sacking 30,000 "phantom civil servants," employees who had never appeared on the job or who were illegally collecting more than one paycheck from the state, to reduce the state's fiscal burden.

But it was in an effort to create jobs that Jereissati made his most effective economy-stimulating maneuver: hoping to keep his meager emergency funds within state borders, he established a comprehensive Public Procurement Program (PPP). At the heart of the plan was a directive requiring that employees of all government-run drought-relief projects must buy supplies, mostly construction materials and tools, directly from local producers, including many small firms. This mandate represented a radical departure from the recent past, when the state government purchased nearly all relief items from larger firms located outside the state.

Given the assurance of a guaranteed buyer, people in the countryside quickly responded by opening hundreds of small businesses—including sawmills, wood workshops, stone pits, and brick factories—to produce relief-related items. But Jereissati wanted to go beyond merely creating make-work jobs only to watch them evaporate when the funds for emergency relief ran out—the typical outcome of most government-subsidized job programs.

To foster broader economic development, a major component of the PPP was to provide firms with technical assistance to help them produce high-quality, low-cost goods. Along the way, Jereissati theorized, the firms would not only create suitable supplies for the relief effort but would also establish a base from which to draw future

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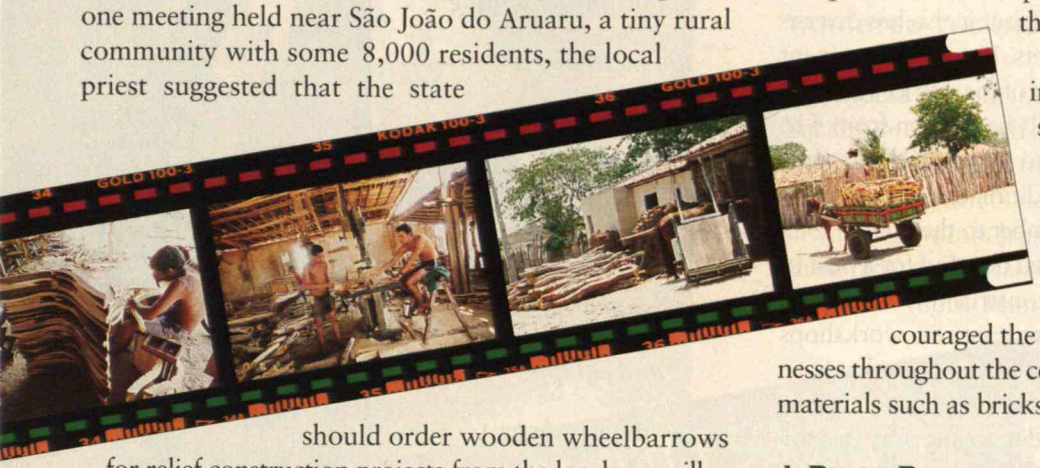
government business and, more important, gain the technical and business expertise they would need to thrive in private markets.

From Adversity to Advantage

When government officials first began discussing how to implement the PPP in 1987, they brought together representatives from all rural areas affected by the drought. In one meeting held near São João do Aruaru, a tiny rural community with some 8,000 residents, the local priest suggested that the state



should order wooden wheelbarrows for relief construction projects from the local sawmills.

During former emergency programs, Ceará had bought iron wheelbarrows from firms located in the south of Brazil. But this time the head of the State Department of Industry and Commerce (SIC)—which was in charge of implementing the governor's new industrial policy—immediately put through an order for 300 wheelbarrows to be delivered in 15 days.

The district of São João do Aruaru, known for its rich woodlands, had long supplied timber for buildings and for wooden trays used in the region's sugar-cane mills. But its four crude sawmills had never produced wheelbarrows, nor so many items in such a short time. In response, the mill owners doubled their work force and consulted with engineers sent by the SIC to select the best materials, tools, and techniques to complete the job.

When the order was delivered, state inspectors were surprised to discover that the wooden wheelbarrows were actually more durable than the iron ones they had been buying, as they didn't rust or dent. The inspectors were also pleased to find that the purchase price was about 30 percent less than that charged by former suppliers, as the state was able to purchase the wheelbarrows directly from the suppliers rather than from intermediaries, and both materials and labor were plentiful in the region and therefore less expensive. Satisfied with the results, the state quickly ordered 2,000 units from the same producers as well as other items required for relief efforts, such as wooden barrels for distributing water and wooden hoe handles for planting crops.

The contracts had a dramatic impact on the lives of people in the district. Those who normally would have earned less than half the minimum wage as farm laborers soon earned up to three times the minimum wage in the sawmills. Many new people entered the sector, not only as workers but also as owners of new sawmills and other small businesses. The community took pride in having produced the wheelbarrows for the emergency program. As one elderly woman from the town put it, "Aruaru proved that the poor also have something to offer the government."

Elsewhere during the drought—in nearly 140 municipalities—the state government enlisted rural workers in PPP projects such as constructing and repairing water wells, health facilities, classrooms, and roads. To help supply all these efforts, the program encouraged the formation of some 100 small businesses throughout the countryside to produce construction materials such as bricks, tiles, and water tanks.

A Pilot Program Soars

As the drought abated at the end of 1987, the SIC and the governor expanded the plan to stimulate small firms to produce many more items required by state agencies. This time, however, the program would be voluntary; the SIC would *encourage* state agencies to purchase from small local firms, but not unless their goods were of comparable or greater value than those produced by larger established firms outside the state.

The SIC first examined the entire inventory of government purchases and then consulted with state engineers to determine which items would not require manufacturing sophistication beyond the reach of small firms. The agency discovered a surprising number of products and services that met both criteria—including furniture for schools and government offices, grain silos, electrification poles, boots and uniforms for the state police, sheets for hospitals, and repair of public buildings—which became new targets for public procurement from small firms throughout the state.

The first new order to São João do Aruaru firms was from the Department of Education in the capital city of Fortaleza, which needed 3,000 school desks and 100 tables for the city's schools within six weeks. Five of the district's seven sawmills filled the order in less than a month with higher-quality, lower-priced furniture than the former suppliers had provided.

As word of such performance spread, other public agencies began to purchase supplies and services from small firms in the state. For example, the Department of Agri-

culture ordered some 20,000 silos from nearly 90 firms in the countryside during the next four years, and the Department of Electrification began buying its supply of electrification poles locally as well.

The Department of Education expanded local procurement of a full range of furniture, supplies, and services. São João do Aruaru, the first and most successful community to participate in the PPP, has been the biggest benefactor. Not only has the district manufactured some 90,000 units of school furniture annually since 1988, but it also has diversified into residential furniture markets. In fact, government orders now represent only 30 percent of the district's sawmill production. The number of sawmills has grown from 4 to 42, and most now employ from 8 to 10 permanent workers and have hired from 4 to 7 additional workers to cut trees, slice the trunks, and deliver timber to the mills.

The growth of the mills has created demand for a host of related activities, such as building construction and equipment repair and assembly. In fact, at least two workshops have switched from sawing timber to fixing and assembling items such as band saws, cheese presses, and sugarcane-processing equipment in order to support nearby sawmills, dairy farms, and sugar mills.

New opportunities have arisen for women. For example, several sawmills began hiring women to paint furniture, a task previously performed by men. The owners say the women are more meticulous than men and like "quiet" work, while men like the noise of the machines.

The district's standard of living has greatly improved. Whereas most families used to live in mud huts, many now own brick houses. Curiously, the owners of the new houses have not demolished the old huts, but keep them to show visitors how their lives have improved since 1987.

The district has also benefited from improved services. New bus lines, particularly those connecting the district to Fortaleza, have been scheduled by the regional bus company. The surge of new business has attracted the attention of the Bank of Brazil, which opened a new branch in São João do Aruaru at the same time it was closing existing branches in larger towns because of the national recession. Most of the sawmill owners now have bank accounts, and some have become familiar with the lending process, a rare accomplishment for rural producers.

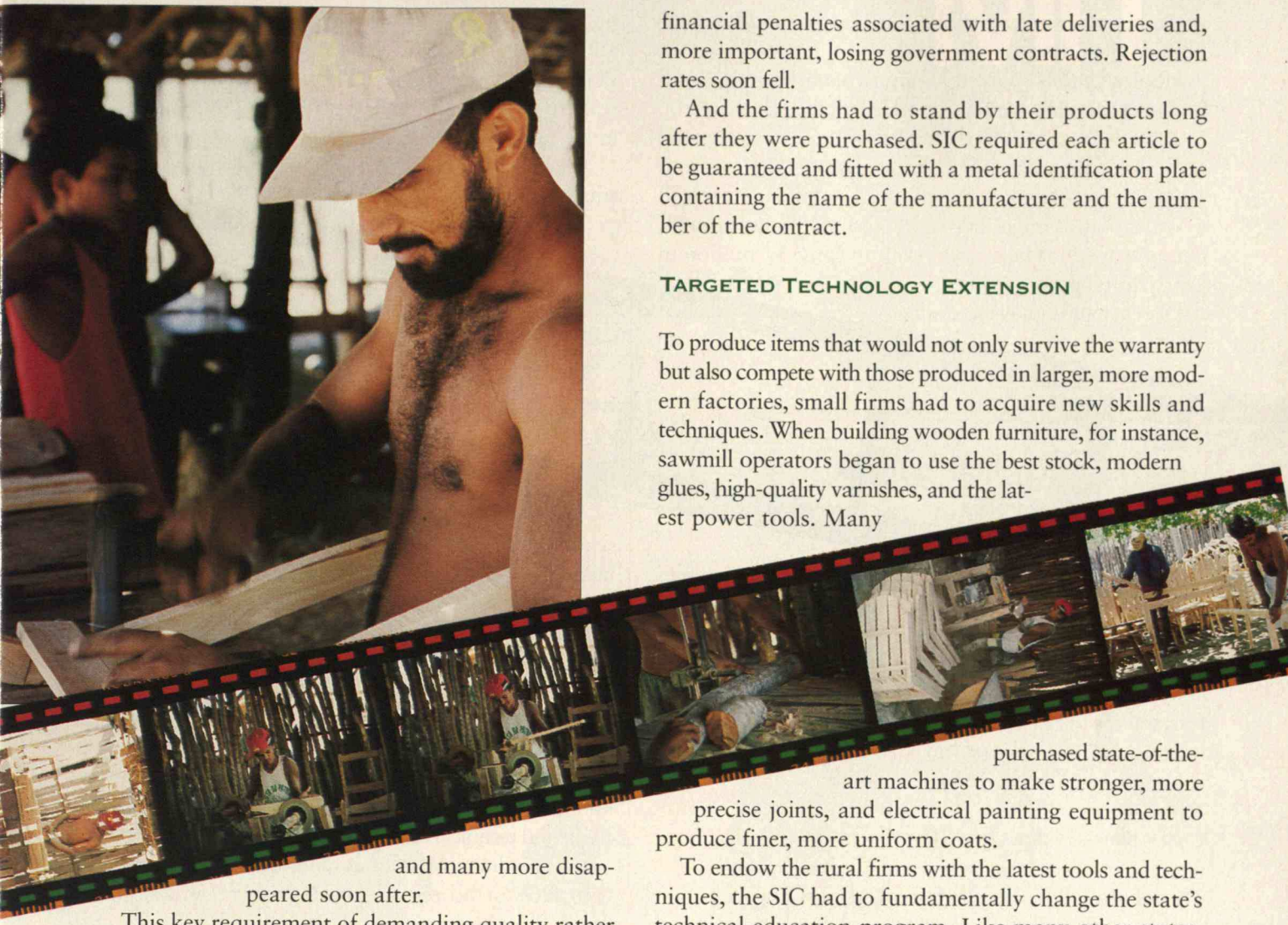
Finally, the sawmill owners in São João do Aruaru have also become politically active. Because they represent the most important economic activity in the area, they try to reach consensus on political issues, such as which mayoral candidate to support. They were also influential in convincing the mayor of their governing municipality, Morada Novato, to open a night school in the rural town, and to pay teachers to drive 45 minutes from the city to teach local students who work in the sawmills during the day.

As the sawmills of São João do Aruaru grew, a host of supporting business opportunities sprang up, including assembly and painting jobs, timber-delivery services, material-supply houses, and equipment-repair shops.

Ensuring Quality

Ceará's PPP provided the direction and support the small firms needed to develop into businesses that could compete in the private sector. But after the first year of the program, the PPP no longer protected them. The state encouraged public agencies to purchase from small firms, but these agencies did so only when it was to their benefit. In fact, the agencies constantly checked prices of products on the open market to make sure they were getting the best deal from local suppliers. The firms were therefore forced to develop high-quality products at competitive prices, and only by doing so were they able to expand their markets.

Conversely, when governments overprotect small firms, public procurement programs usually end in failure. For example, when the Sandinistas came to power in Nicaragua, the government included small firms in a new national industrial program to ensure the availability of basic consumer goods such as food, textiles, clothes, and footwear. But the initiative—which provided extensive subsidies, delivered materials and assistance to the firms, and restricted imports—failed to set quality standards or discipline the firms to become competitive. After the government withdrew subsidies and market guarantees in 1988, a quarter of all small firms died within two years,



and many more disappeared soon after.

This key requirement of demanding quality rather than purchasing indiscriminately from small firms had been completely foreign to Ceará. Before the PPP, government procurement was often determined by bribes, and firms within and outside the state could easily sell low-quality goods or services to public institutions. As a result, almost everything the government bought had a short life span. For example, principals from public schools in Ceará complained that desks often did not last more than three years.

Realizing that delivering quality goods was essential to winning contracts from government agencies and, eventually, the private sector, the SIC wrote strict quality standards into each contract and sent inspectors to the manufacturing sites to make sure that they were being met. At first, some producers doubted that the SIC would actually reject items. While filling the Fortaleza school-furniture order, for example, some tried to use an inferior variety of wood; the resulting rate of rejection for some contracts was as high as 15 percent. Because the inspection teams showed no sign of relaxing the standards, firms quickly realized they would have to be more prudent if they wanted to avoid accruing financial penalties associated with late deliveries and, more important, losing government contracts. Rejection rates soon fell.

And the firms had to stand by their products long after they were purchased. SIC required each article to be guaranteed and fitted with a metal identification plate containing the name of the manufacturer and the number of the contract.

Targeted Technology Extension

To produce items that would not only survive the warranty but also compete with those produced in larger, more modern factories, small firms had to acquire new skills and techniques. When building wooden furniture, for instance, sawmill operators began to use the best stock, modern glues, high-quality varnishes, and the latest power tools. Many purchased state-of-the-art machines to make stronger, more precise joints, and electrical painting equipment to produce finer, more uniform coats.

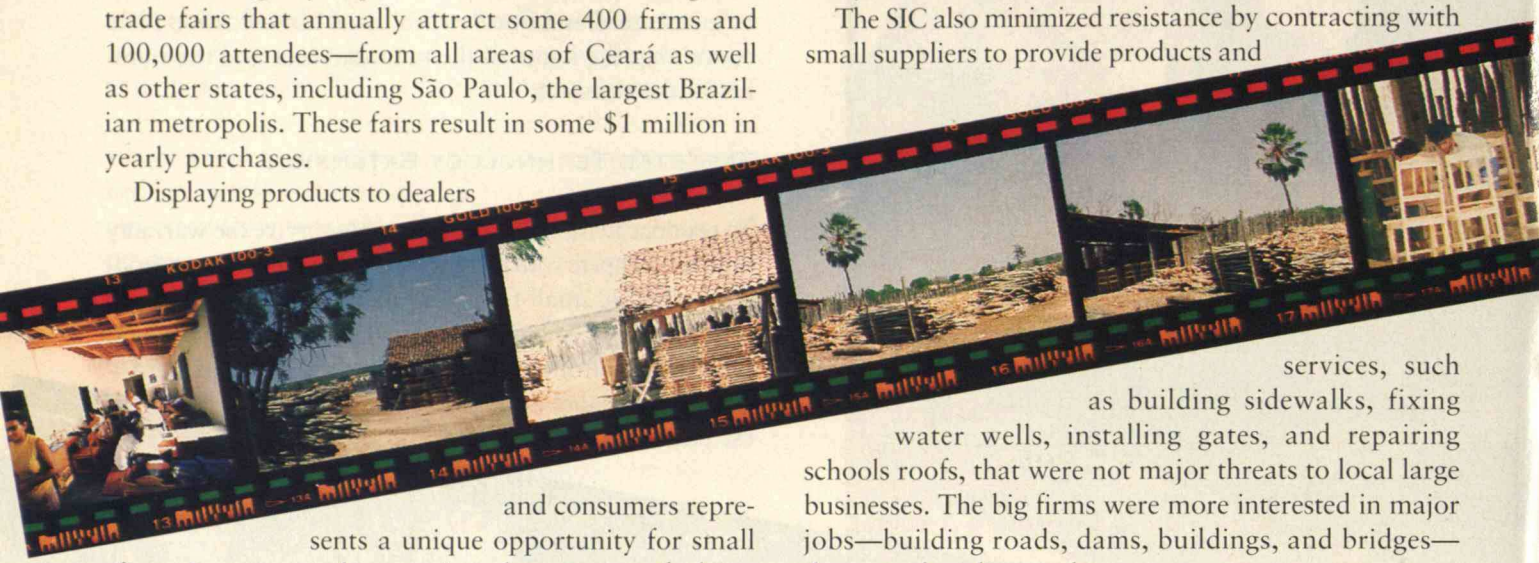
To endow the rural firms with the latest tools and techniques, the SIC had to fundamentally change the state's technical-education program. Like many other states, Ceará's traditional model of technical extension was to offer generic courses that remained virtually the same for every group of participants. For example, a typical course for the food-processing industry had been held at a modern state agency with the latest electrical appliances. But because the classrooms didn't simulate the constraints that firms routinely faced—such as crude equipment, crowded quarters, and energy problems—the trainees had little chance to use what they were taught.

In the PPP model, state engineers traveled to the communities and worked with producers to solve real problems and improve the quality of the products. One civil engineer said that it was only during one of his visits to a sawmill that he learned why the desks it was producing were cracking. He had assumed the culprit was the variety of wood, but discovered that producers had been storing the wood outside in the rain and humidity rather than allowing it to dry indoors more completely and uniformly. SIC engineers also taught producers new techniques, such as a how to choose the best sandpaper for each variety of wood, use special routing machines to make tongue-and-

groove joints, and create better-looking and more comfortable chair designs.

Finally, the SIC played a major role in helping small firms in Ceará market their products to the private sector. In 1988 the agency helped establish a dozen or so regional trade fairs that annually attract some 400 firms and 100,000 attendees—from all areas of Ceará as well as other states, including São Paulo, the largest Brazilian metropolis. These fairs result in some $1 million in yearly purchases.

Displaying products to dealers and consumers represents a unique opportunity for small firms. In one typical interaction, the manager of a large store in Fortaleza ordered 200 twin-size beds from a small sawmill in the municipality of Crato, a purchase that represented the full capacity of the firm for two months. When it completed the order on time, the customer extended the contract for two more years.



Overcoming Resistance

Though the PPP eventually flourished, public agencies that switched their procurement toward small firms faced strong opposition from former large suppliers. Reaction against the PPP came initially from the FIEC, an alliance of all 26 of the state's industry associations, which argued that industrial policy should emphasize large firms. Resistance also came from individual companies. For example, two large firms located in the state of Paraná that used to manufacture 80 percent of Ceará's school desks lobbied hard against the PPP, arguing that small firms would not be able to meet the deadlines. The large firms, even bribed officials to delay the orders.

But the PPP gained strong political support from mayors and other politicians from more than 30 municipalities positively affected by the program. These leaders were able to persuade senators and even the governor to maintain or activate the PPP in their jurisdictions. As the PPP developed, it also gained strong support from people in all of the participating districts. It even improved the morale of people not currently working in the firms, as they looked forward to the possibility of future jobs for themselves or family members. SIC fueled the support by publicizing the PPP's achievements on TV, radio, posters, and newspapers. Advertisements claimed that the PPP makes public procurement "democratic," enables the state to save money, and "represents a measure of austerity and morality."

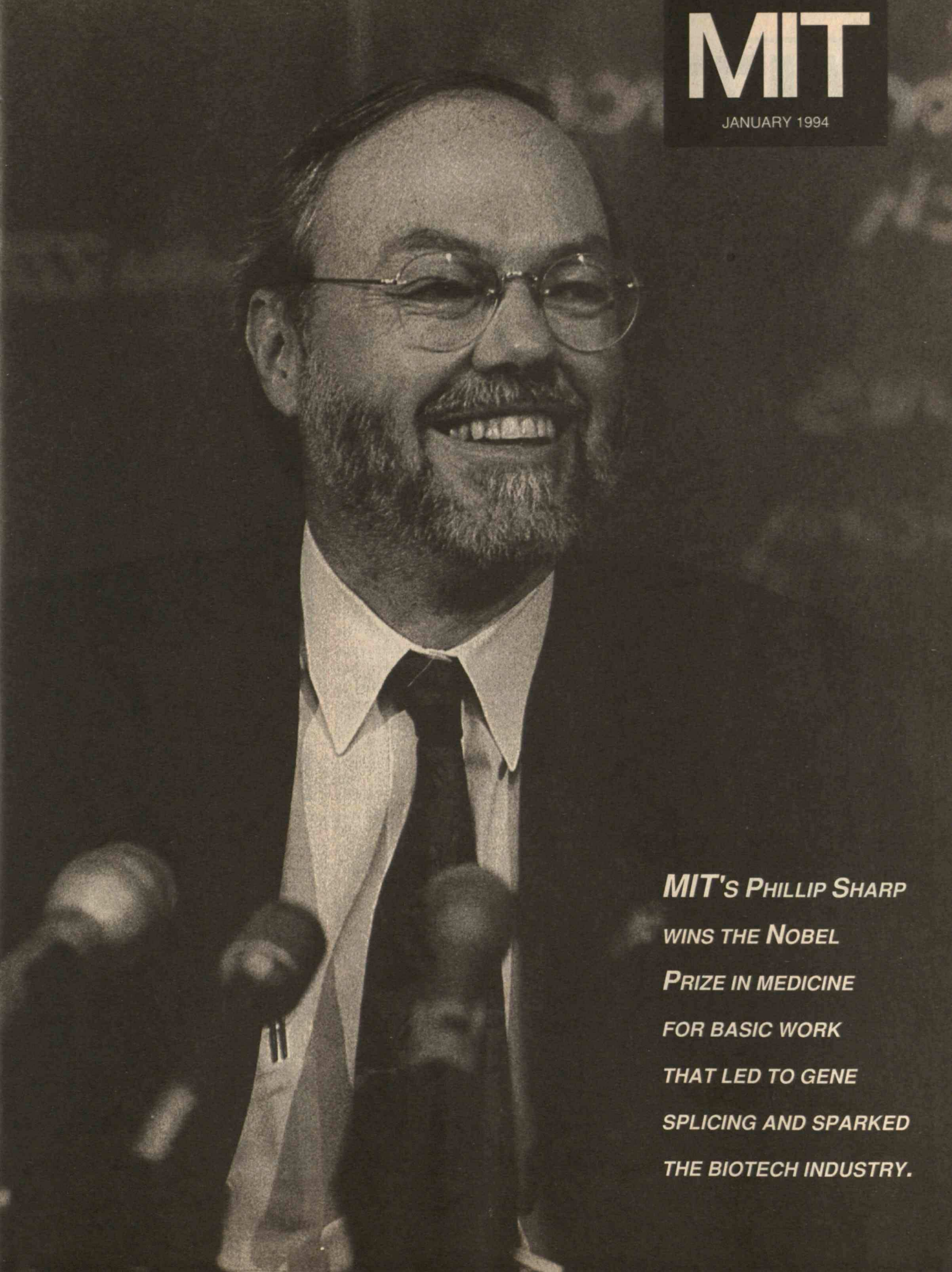
The SIC also minimized resistance by contracting with small suppliers to provide products and services, such as building sidewalks, fixing water wells, installing gates, and repairing schools roofs, that were not major threats to local large businesses. The big firms were more interested in major jobs—building roads, dams, buildings, and bridges—that were less dispersed.

As the experience in São João do Aruaru shows, a government procurement program can be a catalyst for rejuvenating and sustaining a local economy. Unfortunately, most programs for small firms now in vogue in developing countries rely on strategies that address the supply side of the economic equation. That is, they offer small firms financial credit and technical and managerial assistance to help them supply products, often of dubious quality, to the market, with little or no regard for helping create a sustained demand for the products. Firms supported under such programs usually do not "graduate" to the stage where they no longer need subsidized credit. In fact, these programs are usually a short-term fix to generate government-subsidized jobs during periods of severe unemployment; they are rarely a tool for sustained economic progress or broader development.

Ceará's PPP took the opposite approach and focused on heightening the demand for goods produced by small firms. One ingredient of supply-side policy—technical extension—did play a crucial role in enabling firms to improve the quality of their products and ultimately become competitive in the private market. But the other key factor was that, rather than sheltering small companies from competition, the PPP encouraged rivalry between them and larger entrenched firms as a means of preparing the new firms to go it alone. To foster competition, the PPP did not allow the firms to continue to rely on the state to sell their products. Thus the firms could by no means disregard quality and price issues, as the public agencies—and private customers—would simply exercise their option to buy from other suppliers. ■

MIT

JANUARY 1994



MIT'S PHILLIP SHARP WINS THE NOBEL PRIZE IN MEDICINE FOR BASIC WORK THAT LED TO GENE SPLICING AND SPARKED THE BIOTECH INDUSTRY.

MIT
JANUARY 1994

COVER:
The Nobel Prize Committee wasn't the first to notice the accomplishments of biologist Phillip Sharp. One of the most notable of his long list of honors is the Albert Lasker Award for basic research in medicine, almost a routine precursor to the Nobel. And in May, Sharp was named the 1993–94 Killian Award Lecturer, the highest honor the members of the MIT faculty can bestow on one of their colleagues. The citation from the Killian Award Committee termed Sharp "an institutional treasure." Photo by Donna Coveney

UNDER THE DOMES

Nobel Prize in Medicine to Phillip Sharp

Three years ago, Phillip A. Sharp turned down the presidency of MIT, saying that he could not bear to give up his research. This year, one might say that Sharp's passion for research was validated: work he conducted while an untenured junior faculty member at MIT, and which has since revolutionized the field of molecular biology, was recognized with the 1993 Nobel Prize for medicine.

The award, shared with Richard Roberts of New England Biolabs, recognizes the two men's simultaneous but separate discoveries of "split genes." They independently determined that genes in higher organisms, and the viruses that affect them (such as the virus that causes the common cold) were not continuous segments within DNA, as previously believed. Instead, surplus genetic material without encoded messages, later to be called "introns," existed between lengths of meaningful DNA. The ability of the cell to "edit out" this nonsense information is crucial to protein reproduction. At least one cancer and some of the estimated 5,000 hereditary diseases found among human beings are caused by errors in the splicing process.

The discovery by Sharp and Roberts led almost immediately to discovery of RNA splicing, which in turn has had a profound impact on biology and its applications. As Sharp told the *Boston Globe* the day the Nobel telephone call woke him at his Newton, Mass., home, "I can't imagine a field of science that has changed so rapidly over 10 years." In the meantime, Sharp's research has continued to investigate the molecular mechanisms behind the growth of cancers and other biological phenomena.

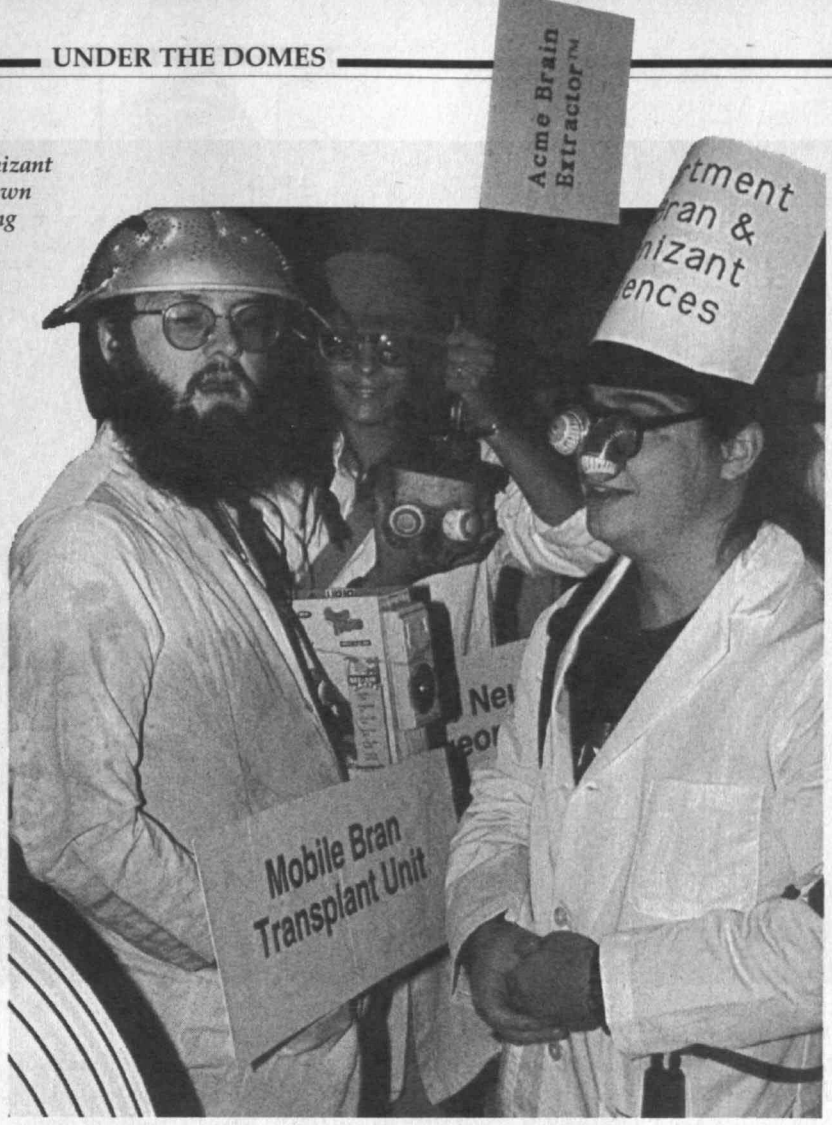
Sharp, 49, who joined the MIT faculty in 1974, heads the MIT Department of Biology and is the former head of the Center for Cancer Research. He is the Salvador E. Luria Professor of Biology at MIT. A year after the discovery that would lead to the Nobel, he helped to found Biogen, the Cambridge-based biotechnology company that was one of the first East-Coast companies operating in this fast-growing field. Sharp's Nobel Prize brings the number of Nobel laureates among the MIT faculty to nine.□

Urban Named Sloan Dean

Professor Glen Urban, a familiar figure at MIT as codirector of the International Center for Research on the Management of Technology, was selected to succeed Lester C. Thurow as dean of the Sloan School of Management, effective Sept. 1. Urban, 53, served as the school's deputy dean from 1987 to 1991 and has been a member of the MIT faculty for 27 years. His presentation on the directions the school will take during his tenure as dean was an important element of the 1993 Alumni/ae Leadership Conference (*see page MIT 9*).

Blending his academic interests with a consumer-oriented strategy in marketing and product development has made Urban much in demand as a consultant among some of the nation's top corporations. He specializes in software-market forecasting models and multimedia virtual environments. He is a cofounder

PHOTO: MIT NEWS OFFICE/DONNA COVENEY



Members of the "Department of Bran & Cognizant Sciences" and the Alumni/ae Association's own Robert Dimmick, AKA Louis XIV, were among some 500 members of the MIT community whose imaginative attire contributed to the 1993 Ig Nobel prize ceremony.

of three firms: Management Decisions, Management Science for Health, and John Snow, Inc., (the latter two specialize in health and family planning). Recently, Urban founded Marketing Technology Interface, a company using multimedia computing to support new-product design. His academic papers have won him numerous awards, including two O'Dells, which are given for the best papers published in marketing research.

MIT President Charles Vest commented that the Sloan School's "combination of discovery of management principles and teaching of business leadership skills is on target at this time of international economic and technological change. Glen Urban is the right person to be at the helm." Early into his tenure in the dean's office, Urban explained that his focus will be an international one, stressing entrepreneurship, product design, and the creation of stronger bridges between business and engineering activities.

Following a year's sabbatical, outgoing dean Lester Thurow, a high-profile author and commentator on international management and economics, will return to teaching and research at Sloan.□

From the Sublime to the Ridiculous

The campus experienced the full range of scientific "honors" in October, all the way from a Nobel Prize to the opposite end of the spectrum. In a crowd-pleasing ceremony that filled Kresge Auditorium, the coveted 1993 Ig Nobel Prize for "Visionary Technology" was awarded to Jay Schiffman of Farmington Hills, Mich., for his invention of AutoVision, a revolutionary image-projection device that makes it possible to drive a car and watch television at the same time. The device consists of a two-inch mirror attached to the windshield in front of the driver's face and a hidden television set, and opens up new possibilities for high-speed distance learning, as well as a new generation of ultra-realistic video games.

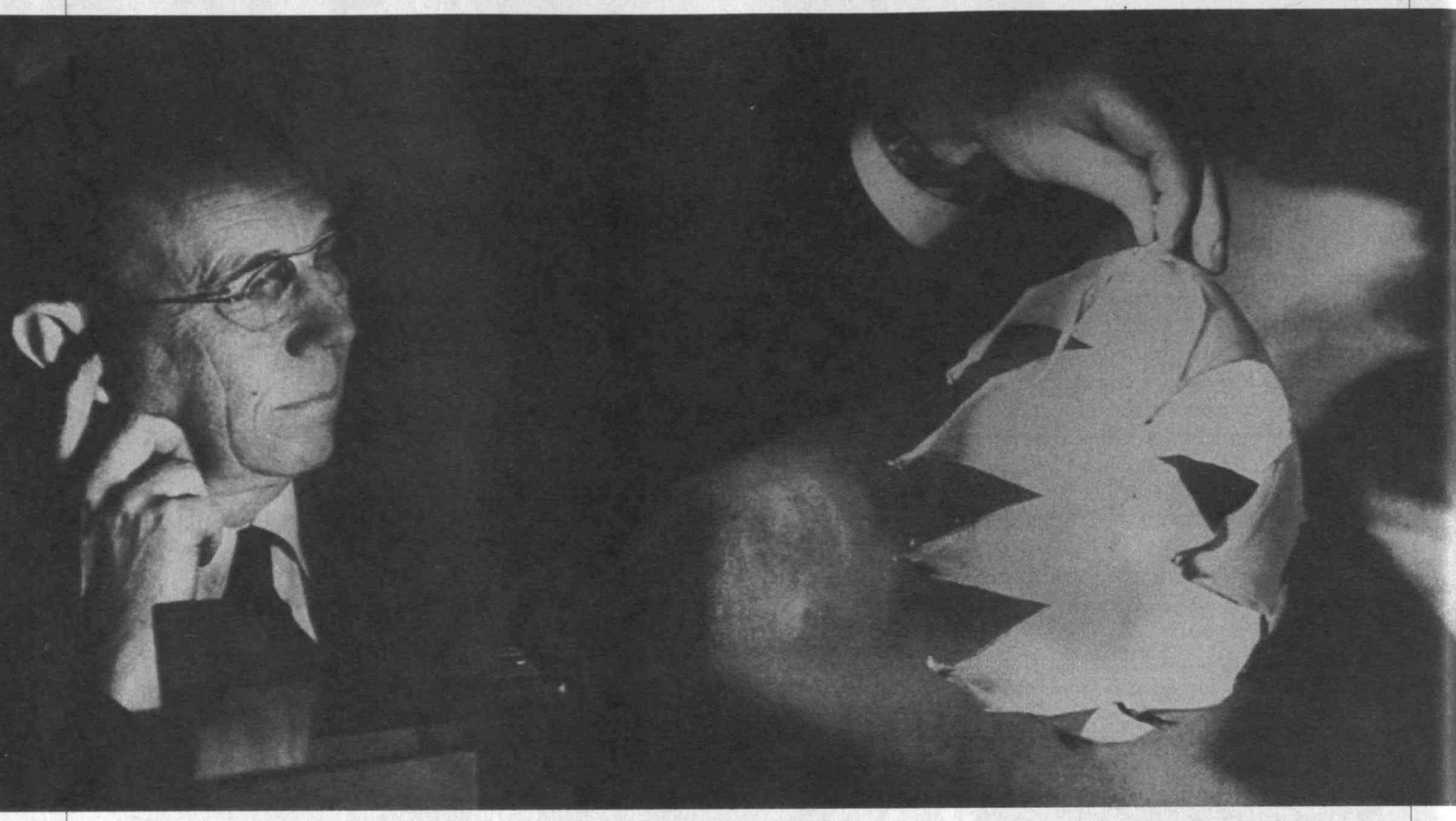
The prize was one of 11 presented at the Third First Annual Ig Nobel Prize Ceremony, sponsored by the pseudo-scientific *Journal of Irreproducible Results* and the MIT Museum (levity department.) The prizes seek to honor "individuals whose achievements cannot or should not be reproduced."

Schiffman shared his prize with the Michigan State Legislature, whose House Bill 4530, Public Act #55, legalizing the use of AutoVision in the state, was signed into law by the governor on June 6, 1991. The inventor turned down an invitation to accept the award in person. "I'm not coming to your ceremony," Schiffman reportedly told Ig Nobel officials, with a flash of insight. "I don't see how this would help my company."

Others receiving the ignominious prizes include:

- Ravi Batra of Southern Methodist University, best-selling author of *The Great Depression of 1990* ($17.95) and *Surviving the Great Depression of 1990* ($18.95), who received the prize in economics "for selling enough copies of his books to single-handedly prevent worldwide economic collapse."
- James Campbell and Gaines Campbell of Lookout Mountain, Tenn., who received the prize in chemistry for their invention of scent strips, "the odious method by which perfume is applied to magazine pages."
- Robert Faid of Greenville, S.C., who won the prize in

PHOTOS: JOURNAL OF IRREPRODUCIBLE RESULTS/ALEXANDRA MURPHY



REMEMBER DOC EDGERTON'S WONDERFUL PHOTOGRAPHS?

Better yet, did you help Doc shoot still photos or movies of experiments with strobe or sonar? If you have any unique prints, negatives, or motion film from projects with Doc, the MIT Museum and the Edgerton Foundation would like to have the material duplicated and added to a digitized archival database. Call Museum Director Warren Seamans at (617) 253-4494, if you know of material that should be included in the project.

mathematics for his ground-breaking work "calculating the exact odds that Mikhail Gorbachev is the Antichrist (8,606,091,751,882:1)." (Faid's complete calculation is contained in the book *Gorbachev! Has the Real Antichrist Come?* published by Victory House, Tulsa, Okla .)

The occasion, which had the distinct atmosphere of a Halloween pageant, was graced by the presence of the King and Queen of Swedish Meatballs, Russell Johnson (professor emeritus, Gilligan's Island), and three genuine Nobel Laureates drawn from the ranks of Harvard University. (The Nobel laureates on MIT's faculty were invited, but all had other commitments.)

"Over the years, many people have asked me, if I was smart enough to make a radio out of a coconut, how come I wasn't smart enough to get us off the island," remarked Johnson, (AKA "the professor"), who gave one of seven 30-second Heisenberg Certainty Lectures. "Well, as you know, one of my degrees was from this institution [MIT], which explains why I was smart enough to make a radio out of a coconut, but wasn't smart enough to get us off the island."

The festivities were marred by protests from the Proton Liberation Organization, who believed that the proposed Superconducting Super Collider would have resulted in the murder of millions of innocent subatomic particles, and MADWWiT (Mothers Against Driving While Watching Television), who painted a terrifying picture of irresponsible motorists barreling down on pedestrians at 60 miles per hour while watching Beavis and Butt-head.□

—Simson L. Garfinkel, '87

In the July issue of* Technology Review, *we blundered: in writing the caption for a photo including Louisa Ho, '81, SM '82 (civil engineering and transportation studies, respectively) and her husband, Carl Van Dyke, SM '81, which accompanied an article on a gathering of transportation professionals* (page MIT 4), *we omitted Louisa's MIT degrees. We also neglected to mention that she is the director of operations, eastern region, for New Jersey Transit Bus Operations. We're very sorry.

PHOTO: MIT MUSEUM; L. BARRY HETHERINGTON

ALUM· NEWS

Awards Presented to Volunteers

At the Alumni/ae Leadership Conference luncheon in October, the Alumni/ae Association (AA) payed traditional tribute to many of its most outstanding members. Before handing out the awards, Association President Richard Jacobs, '56, noted the commitment and hard work of those being honored. "We are proud to claim them as fellow alumni and alumnae and to recognize their achievements today," he said.

THE BRONZE BEAVER, first awarded in 1955 and the AA's highest honor, recognizes distinguished service to the Institute and the Association. This year, six grads were so honored:

■ In addition to caring for a family and pursuing her career as deputy business and financial editor for the *New York Times*, **Karen Arenson, '70,** makes time for MIT. She has served as vice-president of the AA and as a member of the MIT Corporation and its Executive Committee, the Executive Committee of the New York Alumni/ae Center, and the *Technology Review* Board. She also participates in other AMITA and AA projects, and with her husband, Greg Arenson, '70, is co-secretary of their class.

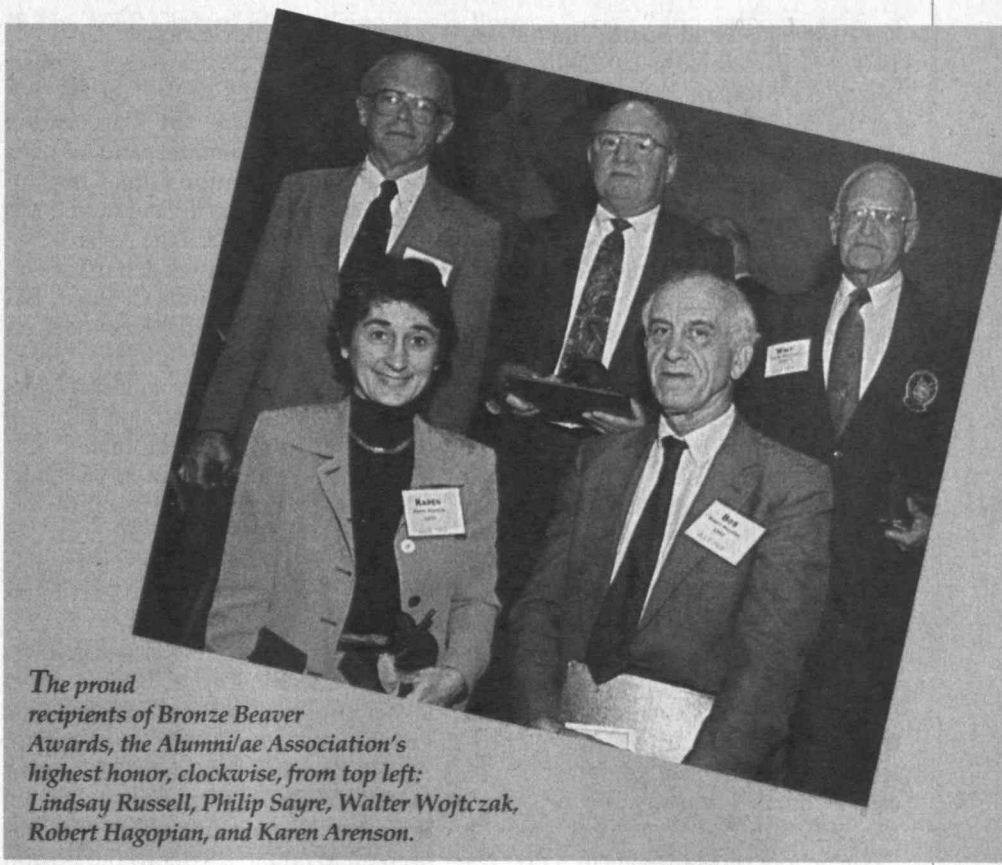
■ **Robert Hagopian, '47,** has distinguished himself in a number of roles for the AA and MIT's Resource Development office. As an officer of the Alumni/ae Fund and an executive officer of the National Business Committee over the course of two capital campaigns in the last twenty years, Hagopian has made many friends for MIT and converted many of his fellow graduates to contributors.

■ **Lindsay Russell, '50,** has served his fraternity, Theta Delta Chi, for decades, extending his efforts far beyond any formal office by offering himself as an advisor, mentor, and friend to all the young men in residence. That dedication to the needs of today's students has carried over to the Independent Residence Development Fund allocation board—where he has worked since its earliest days—and the Class of 1950 Student Financial Aid Fund.

■ **Philip R. Sayre, '54,** has served in all the officer positions of the MIT Club of New Haven. He has worked for the Alumni/ae Fund, served on the Association Board of Directors, and chaired the AA Audit and Budget Committee, the Connecticut Enterprise Forum, and the 1990 Alumni/ae Fund Visit Program in southern Connecticut. Sayre's diplomacy, patience, and discernment were invaluable when he chaired the committee to examine the future and relocation of the New York Alumni/ae Center.

■ **Jack C. Tang, '49,** is the second of a three-generation MIT family and has committed himself to fund-raising for the Institute in the Far East. Tang led the MIT Club of Hong Kong and served as vice-chair of the Leadership Campaign and as a member of a Corporation Visiting Committee and the Corporation Development Committee. To honor the memory of his father, Ping Y. Tang, '23, Jack and his family supported the building of the Ping Yuan Tang Residence Hall in 1972. The Tang family's recent support will help build the Jack C. Tang Center for Management Education and sustain the Tang Scholarship Fund.

■ **Walter S. Wojtczak, '37,** began his volunteer efforts long before MIT had a database capable of tracking such contributions. His history of service includes chairing a Second Century Fund Committee, directing the MIT Clubs of Southwest Florida and Hartford, Conn., and working on Reunion and Reunion Gifts Committees for his class. He has also been a member of Alumni Council,



The proud recipients of Bronze Beaver Awards, the Alumni/ae Association's highest honor, clockwise, from top left: Lindsay Russell, Philip Sayre, Walter Wojtczak, Robert Hagopian, and Karen Arenson.

PHOTOS: L. BARRY HETHERINGTON

Recipients of Morgan Awards for their contributions to the Educational Council, David Dobos (left) and Richard Molari, Jr.

Lobdell Awards for depth of service over time, went to, clockwise from top left: Albert Chen, '91 (accepting for his mother, Concordia Chen), Arlene Taylor, Arthur Winston, Milton Slade, John Erdman, L. Robert Johnson, and Melinda Skaar.

the Alumni/ae Fund Board, and the AA Board of Directors. In 1982, Wojtczak received a Morgan Award for 35 years on the Educational Council.

THE HAROLD E. LOBDELL '17 Distinguished Service Award was presented to eight alumni/ae, recognizing their special depth of service over a sustained period:

■ **Concordia Chen,'62,** has devoted countless hours to the task of co-president of the MIT Club of Mid-Hudson Valley, helping to revive the club and its activities. Her enthusiasm has inspired other grads to become involved on behalf of the Institute.

■ **Joseph E. Dietzgen,'41,** is a gracious volunteer, willing to work in any capacity. He has served on the Technology Day Committee and the MIT Clubs of Chicago and Cape Cod, has held nearly every class officer position, and is a dedicated member of the Institute Advisory Council of the MIT Council for the Arts.

■ **John H. Erdman, Jr., SM '75,** is a dedicated and thoughtful volunteer whose efforts for the *Campaign for the future*, the MIT Club of New York and the Sloan School of Management reflect his commitment to the Institute.

■ An influential class leader, **L. Robert Johnson, '63,** has served on the AA Board of Directors, the Corporation Development Committee, and his class Reunion and Reunion Gifts Committees. His effectiveness in fund raising was honored with a 1988 Kane Award.

■ Through her creativity, hard work, and enthusiasm, **Melinda C. Skaar, SM '87,** has enhanced the diversity and quality of programming, inspired more young alumni/ae to join club leadership, and improved the overall operations of the Club of Southern California.

■ The dedication of **Milton G. Slade, '48,** as a fund raiser and class officer distinguishes him as a great supporter of the Institute, and his class's outstanding 45th reunion owed much to his tireless efforts as reunion chair.

■ The creative and enthusiastic involvement of **Arlene F. Taylor, '83,** extends to all her efforts, whether working for the Educational Council, the Corporation, the AA Board of Directors, her class, or the MIT Club of Colorado.

■ **Arthur W. Winston, PhD '54,** has been an invaluable asset to the Boston Seminar Series, the Technology Day Committee, and the Graduate Alumni/ae Task Force.

THE GEORGE B. MORGAN '20 Award was given to five alumni in recognition of sustained excellence in all aspects of Educational Council activity:

■ Since 1979, **David A. Dobos, '77,** has been an enthusiastic educational counselor, assisting the Columbus, Ohio, regional chair in every capacity. When traveling in other parts of the country, he contacts other members of the council and seeks opportunities to meet with prospective applicants.

■ **Charles R. Greene, Jr., '56,** joined the Educational Council in 1972 and, since 1975, has served as regional chair for the Santa Barbara region. Greene hosts an area meeting for admitted students and their parents, and he also stays in contact with the students he has interviewed.

■ **Richard E. Molari, Jr. , '65,** is the only educational counselor in Massachusetts' Berkshire County, giving MIT visibility in a community where it would otherwise be lacking. Since he joined the Edu-

Alumni/ae accepting Presidential Citations on behalf of their organizations, back row from left: Marita Gargiulo Holl, '77, of the MIT Club of New Haven; Robert Howard, '67, of the Club of South Florida; Joan Leung, MAR '77, of the Club of Hong Kong. Front row from left: Gordon K. (Ken) White, SM '69, Sloan Club of Boston; Jack Drake, '54, Club of Hartford; Gideon Miller, SM '87, Sloan Club of Boston; and William Rousseau, SM '36, Class of '36 Chemical Engineering Practice School Group.

Fund-raisers par excellence, thereby earning Kane Awards, from left: Richard Kruizenga, Richard Kovalcik, Jr., and Kenneth Wang.

cational Council in 1970, his informative interview reports have been an asset in the MIT admission process.

■ **J. Michael Morrisey, '64,** joined the Educational Council in 1980. As regional chair since 1984, Morrisey attends to every detail in the Atlanta, Ga., area—ensuring MIT representation at college fairs, hosting staff members from the Admissions Office, and opening his home for admitted students.

■ **Richard M. Towill, '51,** has served as educational counselor in Hawaii since 1958 and has acted as regional chair since 1976. Through his careful and considerate correspondence, he has kept the Admissions Office well informed of developments in his area.

PRESIDENTIAL CITATIONS recognize distinguished service of alumni/ae groups and programs. Five groups were so distinguished this year:

■ The **Class of 1936 Chemical Engineering Practice School Group** is an exceptional fellowship, which has maintained close ties among the members and with the Institute and raised significant funds to support current students.

■ The **MIT Club of Hong Kong** was honored for organizing—with the Sloan School—a successful two-day symposium on doing business in the Pacific area that heightened MIT's profile in the region.

■ The **MIT Clubs of New Haven and Hartford** co-sponsor an annual meeting to welcome newly admitted students from their areas of Connecticut. This gathering celebrates MIT's past, present, and future, since it introduces the incoming crop of freshmen to alumni/ae and to a group of current MIT students who make presentations on their UROP experiences.

■ The influence of the **MIT Club of South Florida** over the past four years has been testament to its members' hard work and dedication. Through many successful events—such as a discussion of Miami's reconstruction after Hurricane Andrew that featured leading architect Rufus Nimms and drew more than 200 attendees—the club has provided a valuable service to the Institute by enhancing the image of MIT in the community.

■ The **Sloan Club of Boston** created the Boston Career Management Series, a unique set of evening seminars to help alumni/ae in the Boston area deal with the personal and business problems posed by balancing individual needs, family, and a career. These direct and compassionate seminars proved of particular value to members of the audience who were facing major career transitions.

THE HENRY B. KANE '24 Award was established in 1987 to recognize exceptional service and accomplishment in fund raising. This year, four alumni were so honored:

■ **John K. Castle, '63,** served as chairman of the New York Campaign Committee during the *Campaign for the future.* His active participation in the CDC 1991 retreat helped with a series of significant changes in the committee's purpose and structure. Castle advises Institute senior officers and Resource Development staff while continuing his role on the CDC.

■ **Richard Kovalcik, Jr. ,'79,** demonstrates his belief in MIT and the Alumni/ae Fund by making time for every Boston area telethon. He has

Once considered a "soft," descriptive science, biology has undergone an information explosion, becoming much more rigorous and relevant to industry and societal problems.

served as class agent for ten years, and has served on the Alumni/ae Fund Board.

■ **Richard J. Kruizenga, EC '56,** has been an active leader in fund raising activities for more than a decade, serving as a member of the Corporation Development Committee and of the Alumni/ae Fund Board, chair of the Alumni/ae Fund Visit Program in Dallas, and vice chair of the Personal Solicitation Program.

■ **Kenneth Wang, '72,** was a member of the New York Campaign Committee during the *Campaign for the future*, is a member of the Corporation Development Committee, served on the CDC Steering Committee, and solicited for his Reunion Gift Committee.□ —*Amy Souza.*

ALC Focuses on Curricula

As President Charles Vest put it, the Alumni/ae Leadership Conference in October gave MIT's most active volunteers a welcome chance to look not at the "means to the end"—as they might in countless sessions on fund raising—but at the "end" itself: MIT's undergraduate programs. Faculty speakers offered examples of new programs and curriculum changes made in recent years, some to better prepare graduates for tomorrow's working world, others to better integrate and encourage new faculty and first-year students at the Institute. And, as promised by Alumni/ae Association President Richard Jacobs, '56, in an open letter to his constituents in the October *Technology Review*, the magazine's reporting of the meeting gives those grads who did not attend some insight on how curricula that are considered first-rate can still be improved.

Biology Requirement

In explaining the importance of adding a biology course to MIT's core curriculum, Professor Eric Lander conveyed the enthusiasm for the burgeoning field that made him a convert, after earning a doctorate in mathematics at Oxford and teaching management at Harvard. In decades past, biology may have been seen as a "squishy, soft, and descriptive" science, according to Lander. But an "information explosion" has created a much more rigorous field, full of interconnections between molecular biology, biochemistry, and genetics.

"Biology has become an extraordinarily relevant subject to commerce and industry—also to societal problems and questions. It is one of the most exciting intellectual frontiers as we go into the next century," he said.

Offering a taste of the new required course, Lander walked his audience through the question of why we may inherit a disease along with other traits such as eye color or height. He briefly outlined the progression of genetics from Mendel's study during the 1860s of inherited traits in peas to the early discovery of chromosomes in the 1900s and, fifty years later, of DNA. The course also looks at the "engineering" of living things—the receptors, transporters, and sensors that make up what Lander calls "exquisitely designed cellular machines."

Illustrating the tremendous progress scientists have made in recent years, Lander said that the work of discovering the three missing markers that signal cystic fibrosis—out of three billion markers in strands of human DNA—was comparable in scale to looking at the entire globe from space and finding a small patch of skin on a hand on a blanket at a park in downtown Chicago. The discovery of those markers has led to the mapping of more diseases.

Alumni/ae in the audience seemed most concerned about the ethics and societal implications of a field where scientists now can manipulate DNA and detect diseases before symptoms appear. Responding to their questions, Lander said the course finishes up with a segment on ethics, which is taught by the biology faculty. It's important for students to see scientists as well as humanists dealing with such questions, Lander said, noting that the biologists "try not to teach this didactically," instead raising questions for students to consider.

Educating the Professional Engineer

The biology requirement was not created, as Lander joked, because MIT students weren't working hard enough, but because an understanding of the field will be critical to graduates as they lead the workplaces of the next century. The same long-term concerns motivated the new five-year degree programs in electrical engineering and computer science and in aeronautics and astronautics. "People have argued for years now that four years is not enough for a sound professional education and that there is more technical material that one needs to cover," explained Joel Moses, PhD '67, dean of engineering.

For many years, discussions of the five-year program were hung up on the realization that the thesis required in MIT's master of science (SM) in engineering programs often extends past two years and is research-oriented, pulling students from the workplace even longer. Moses said that the break came when faculty agreed to build the new option on the co-op model. Co-op engineering students earn SB and SM degrees in five years, working on an in-plant thesis during the fifth year under faculty supervision. Master of engineering students follow the same plan but can opt to do their thesis on campus. Funding for the fifth year of study usually comes from co-op work assignments.

Moses noted that benefits of the program, in addition to better workplace readiness, include a more flexible curriculum in which students take a base of eight subjects and then choose from concentration areas such as bioengineering, artificial intelligence, and com-

As the Harvard and Stanford business schools set themselves apart from their universities, Sloan is doing the reverse.

puter systems. The program, now underway with sophomores, offers to students in Course VI new opportunities to combine EE and CS offerings, and will enable aeronautics and astronautics majors to participate in a major team-design project before they leave MIT.

New Direction for Sloan

Students earning master's degrees in engineering won't be the only MIT graduates leaving campus better prepared for the workplace. Glen Urban, newly named dean of the Sloan School of Management, told alumni/ae that his focus will be on redirecting the school's programs based on a tried-and-true management practice: listening to the customers' needs.

"Students, alumni, and businesses told us they wanted a shorter core curriculum, more relevance (to the workplace), more flexibility, and more leadership-team experiences," said Urban, a specialist in management science and marketing. (*See article on Urban as new Sloan dean, page MIT 2.*)

Corporations of the twenty-first century will be lean-staffed, Urban said, with a flat, partnership-style hierarchy and an entrepreneurial ability to respond to market changes. Looking at these and other business trends, the school has created new tracks within the master's program that cover financial engineering, financial management, strategic global management, and product development and management.

Change is necessary, Urban said, because the competition from other elite business schools is keen. But while the two chief competitors—Harvard and Stanford—have set themselves apart from their larger universities and raise funds independently, Sloan is doing just the opposite, emphasizing MIT's traditional strengths and their value in a management program. " If the networked corporation is coming—companies that are flat, agile, and data-intensive—then we are uniquely positioned to lead," Urban said.

In the Spirit of Doc Edgerton

The three-year-old Edgerton Center is one of MIT's more recent projects aimed at reaching out to undergraduates, particularly in the critical freshman year. Supported by the Edgerton Foundation, the center seeks to preserve the spirit of Harold "Doc" Edgerton, ScD '27, the MIT professor whose ability to inspire students and colleagues is as treasured as his celebrated breakthroughs in strobe photography and sonar.

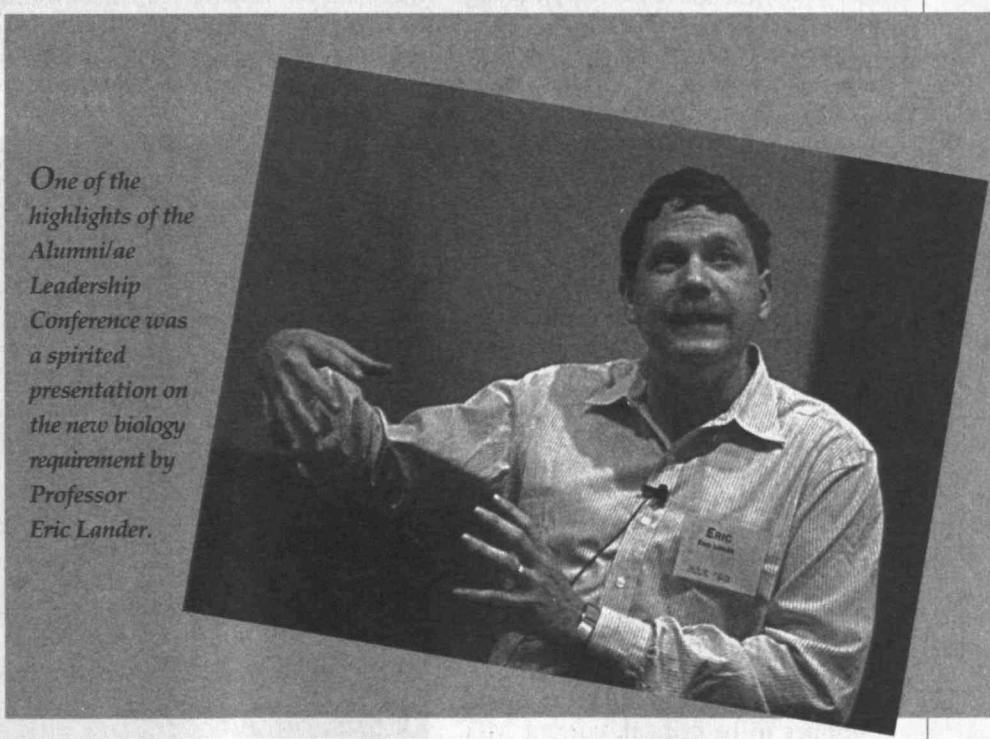
The foundation wanted to promote Doc's style of undergraduate teaching: encouraging students to get their hands dirty (or wet) by doing everything from scanning the Charles River with sonar to conducting experiments in the Mediterranean with Jacques Cousteau.

"Freshmen arrive with less hands-on experience than ever before, " said Charles Mazel, SM '76, a research engineer in MIT's Department of Ocean Engineering and a lecturer with the center. "No one builds ham radios anymore, or works on their cars."

Working with a half dozen or so faculty affiliated with the center, freshmen are encouraged to pursue projects as diverse as tracking tuna, collecting ocean data, and applying fiber optics. The center helps the students identify topics where interesting work is going on, helps them to gain access to labs, tools, and materials, and offers guidance. Along the way, such projects also help break down a perceived barrier between faculty and undergraduates, Mazel said, and provide a balance to the heavily abstract subjects that comprise a typical first-year curriculum.

Offering Edgerton-style philosophy on hands-on learning, Mazel noted, "Industry needs people who not only know things but who know how to do things."

Commented an alumnus who seemed intrigued by the presentation: "Change that to *society* needs people who know how to do things." □ —*Lisa Watts*



One of the highlights of the Alumni/ae Leadership Conference was a spirited presentation on the new biology requirement by Professor Eric Lander.

MIT'S ILP

A Program Under Fire Becomes an Asset

By Lori Valigra

In retrospect, MIT's Industrial Liaison Program (ILP), established in 1948, seems a prophetic answer to current demands by Congress to boost U.S. competitiveness through cooperation among universities, government, and industry .

One of the first organizations established by a university to make the work of its laboratories and investigators accessible to industry, the ILP now offers to its 220 member corporations some of the broadest access to research of any comparable campus program.

In recent years, however, the program's prominence and MIT's openness in forging ties to companies and entrepreneurs worldwide have attracted scrutiny from members of Congress and others concerned that the ILP might be "selling" the results of publicly funded research to overseas competitors of U.S. industry.

Confident that the appropriateness and wisdom of the ILP's mission and strategies were evident to those outside as well as inside the Institute, former MIT President Paul Gray, '54, was caught off-guard in June 1989 when testifying before a House of Representatives subcommittee on foreign access to federally funded research. In a session that marked a watershed in MIT's institutional memory, Gray encountered intense criticism of the ILP's open-door policy .

Because public debate on the issue continues to be critical, current MIT President Charles Vest and both government-relations and ILP staff are articulating the benefits of MIT programs like the ILP at every opportunity. The establishment of an MIT Washington office in 1991 and frequent visits by Vest to the nation's capital are indicators of the seriousness of their efforts.

"We are trying to work with Congress and other branches of government to describe what we do, how we work and interact with the rest of MIT, and our rationale for involvement of non-U.S. firms," says ILP Director Thomas R. Moebus, '70. Such efforts are timely: the value of the ILP model to federal laboratories seeking liaisons with industry (part of a post–Cold-War retooling of their missions) may tip the scales in MIT's favor.

For federal laboratories redefining their missions in the post-Cold War era, the ILP may provide a model of how to make research accessible to U. S. industry.

Moebus foresees the university-industry connection strengthening in the continuing soft economy, which has forced U.S. companies to rely more and more on outside research to supplement or supplant their own R&D activities. In situations where internal researchers can show that their programs are moving along in tandem with leading-edge activities at MIT, the working relationships set up through the ILP can even help industrial R&D justify its keep.

Take the case of TRW , an ILP member for 10 years. Several years ago, the Cleveland-based company collaborated with Joel Clark, ScD'72, professor of materials science and engineering, to develop a computer model that showed the cost differentials of manufacturing auto parts using several alternative materials and processes. "This helped us to make sure our technology investments were in the right area," said Istvan Toth, TRW's liaison with the ILP.

But with TRW tightening its research budget, Toth says the company will have to do more with less. "We are not covering all the bases," Toth explains, "and a larger and larger percentage of our technology sourcing comes from outside." Universities are one part of that equation, along with strategic industrial partners throughout the world.

The ILP put itself in a position to learn from such changes shaking American industry by setting up an advisory panel of corporate members several years ago. "They're struggling with a difficult economy, strong competition from the rest of world, and a lot of jobs cut out of R&D," says Moebus. "This means companies are almost not doing research, but focusing on getting products to market." He says that companies are looking for more deliverable outcomes from all their relationships.

"Research groups within corporations are competing for resources. So to get funding for the ILP, they must argue it is a good investment," notes Arden Bement, the former ILP liaison at TRW and now an engineering professor at Purdue University in Indiana. In this climate, MIT's efforts to publicize the merits of the ILP not only stand to win over government critics, but they can also support proponents within corporations who are lobbying for ILP membership.

Looking Beyond the Short Term

As a fee-for-services operation within MIT's resource development organization, the ILP helps corporate members keep up with research advances through topical seminars both on and off campus, a monthly research newsletter, and access to a database of campus researchers and their areas of expertise. Though the National Science Board lists MIT as the site of one of about 40 university-industry liaison programs in the United States, the Institute is one of the few schools offering campus-wide access rather than just links to specific labs.The price tag for all this: an average of $33,500 annually for American members, $48,367 for Europeans, and $51,833 for Japanese, with fees based on the size of member companies.

Ironically, many corporations have fallen short in taking advantage of their investment. "Engineers or scientists are more involved with the problems at hand than with getting new contacts," Arden Bement believes. "You have to get busy people to raise their heads above the battleground to see what is going on outside the company. It doesn't occur to people that there's help." Many industry analysts agree with Bement. Rather than blaming foreign competi-

ILLUSTRATIONS: BRUCE MADDOCKS

tors for "stealing" American research, U.S. corporations should seize opportunities, critics say.

"It's an open environment, so Japanese and Koreans can come to cultivate people. I wish U.S. companies would use U.S. universities in the same way," said Varadachari Sadagopan, ScD '65, a researcher at IBM's Watson Research Center in Yorktown Heights, N.Y. (IBM has been an honorary member of ILP for about 30 years, in recognition of the company's substantial donations of money and equipment to MIT.)

Short on qualified research staff and experience at home, Japanese corporations have rushed to tap know-how in the United States. Nineteen percent of the ILP's 220 corporate members are Japanese companies, making them the second largest contingent after the 54 percent from this country.

Economic analysts agree that a distinguishing feature of Japanese companies is that they don't expect immediate return on investment. One example is Mitsubishi Kasei Corp., based in Tokyo. Mitsubishi Kasei has grown to be a $5 million company by making organic chemicals, but it is branching into new areas like polymers and ceramics, pharmaceuticals, and information and electronics. Its approach to MIT is open-minded, broad, and aimed at the future.

"We'll soon have a contract with some MIT faculty for polymers for basic research," says Kazuhiko Onuma, senior manager of R&D at Mitsubishi Kasei. "I don't expect a commercial profit [right away.] It is very important to keep abreast of the newest developments."

Similarly, Ishikawajima-Harima Heavy Industries Co., Ltd. (IHI), a Tokyo manufacturer of heavy machinery and ships, uses its contacts with MIT to follow developments in design and robotics. The company has its own research staff of about 1,000, but most are engineers—only 5 percent are scientists. "The MIT affiliation is valuable not for any commercial products or applications," says Kazuo Sezaki, associate director of technical development at IHI, "but for engineers to get exposed to the ideas and thinking of the top scientists at MIT."

Universities produce "pre-competitive research," whose results only acquire commercial value when applied by industry.

Two-Way Exchanges

It is such affiliations that concern some members of Congress, who worry that interactions with some foreign nations, notably Japan, are a one-way street. But in a recent survey of MIT faculty, 77 percent said they benefited from contacts with European academics and 29 percent said they benefited from contacts with European industry. For Japanese contacts, the numbers were 52 percent and 25 percent, respectively. About 29 percent said they have passed research from Europe on to contacts in U.S. industry, and 20 percent have given U.S. industry research information from Japan.

Researchers say they do not have the time to engage in interactions that don't involve a two-way exchange. "Most of the time I meet someone worth meeting," said David Zeltzer, a principal research scientist at MIT's Research Laboratory of Electronics. Zeltzer traveled to Japan in May of last year to head an ILP seminar on virtual environments and to visit companies, including NEC Corp.'s virtual reality lab. "It is useful to make collegial contacts," he says, "and it may lead to some directed research or consulting." Zeltzer adds that no information is divulged that is not available in the technical and scientific literature.

NEC also believes that the exchanges work both ways. The Japanese communication giant sends about 30 researchers to the United States every year and accepts 20 to 30 visits annually from MIT researchers, reports Masakatsu Sano, the company's engineering manager.

But to non-scientists, the content of such exchanges is largely a mystery that can actually fuel international trade tensions. In the view of some members of Congress, the results of federally funded research are being handed over to foreign firms, and no special consideration is given to U.S. corporations. The ILP's Moebus says that this misconception demonstrates why it is critical for MIT to explain to politicians how research universities operate, how the conversation about research moves from place to place, and why it is valuable to have international exchanges.

Researchers argue that the outcomes of their work are not products in themselves. IBM's Sadagopan categorizes university investigations as "pre-competitive research." That is to say, basic science and technology provide results that yield commercial value only when they are applied by companies patiently and intensely over the long term. □

LORI VALIGRA, who specializes in Asian business and technology, recently completed a year as a Knight fellow in science journalism at MIT.

JANICE VOSS, PHD '87

MIT's First Woman in Space

BY RUSSELL HOWARD, PHD '90

Flight STS-57 took off one day late, landed two days late, and after a 10-day flight, touched down just four miles from where it began. But for Janice Voss, PhD '87, and the rest of the crew of the space shuttle *Endeavour*, the journey that was launched in June 1993 was not only the ultimate in business travel, it was the stuff of dreams. What's important to NASA and the taxpayers who underwrite the program is that STS-57 was the maiden voyage of the SpaceHab module, a tiny, low-gravity research facility that could make a notable contribution to future commercial and scientific operations in space.

To help demonstrate the utility of the privately developed SpaceHab, NASA has taken out a five-year lease on the module that will cover a number of flights. Private industry, branches of NASA (particularly its Centers for the Commercial Development of Space), and other U.S. and overseas agencies apply for SpaceHab berths, and the most successful proposals are those that demonstrate both technical soundness and potential commercial viability.

Voss is the first female graduate of MIT in space, and as the SpaceHab specialist on the crew, she was reponsible for many of the experiments. SpaceHab is a compartment that extends into the shuttle payload bay. It provides 1,100 cubic feet of pressurized space, quadrupling the working and storage area available in the orbiter.

On this voyage, for example, Voss monitored the growth of gas-permeable polymers for such applications as extended-wear contact lenses and dialysis filters. The experiment was designed to determine if certain polymers made in low gravity differ from the same molecules synthesized on the ground. Other applications for the molecules Voss tested in this study include filters for blood-gas monitoring and control of fermentation and other industrial processes. She says that the sponsors were so impressed by early results that they are scrambling to be on SpaceHab's second flight.

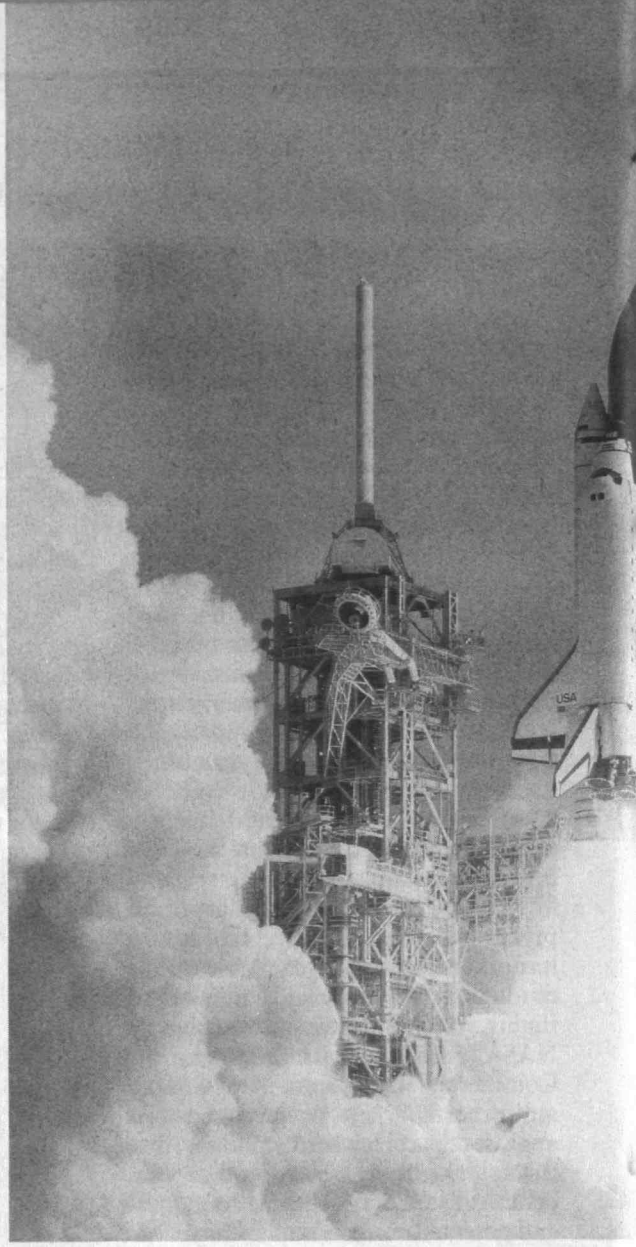
A number of the experiments on SpaceHab related to crystal growth, an area in which the hopes for commercial applications in space are particularly high. Crystals grown in the absence of gravity are expected to be larger and more perfect, and in about 20 percent of the experiments to date, that's been the case. Among Voss's tasks on STS-57 was growing protein crystals by vapor diffusion, a process expected to be valuable for the production of pharmaceuticals, and an experiment to further understanding of the growth of zeolite crystals. Valued for applications as catalysts, molecular sieves, absorbents, and ion-exchange materials, zeolite crystals are considered particularly promising for manufacturing operations in earth-orbit.

Another experiment involved gathering data about naturally occurring radiation in low earth orbit, which influences the long-term health of astronauts and is still poorly understood.

Voss was also responsible for overseeing a "secondary payload," referred to as SHOOT: Superfluid Helium On-Orbit Transfer. Liquid helium is used to cool many of the infrared detectors used in astrophysics and Earth-observation satellites. Since the helium gradually vents into space, it limits the lifetime of these instruments. SHOOT was the first demonstration of the technology needed to replace liquid helium supplies in orbit. It also achieved the lowest temperature ever reached in orbit (1.1 degrees Kelvin) and made observations of thermal lay-

With camera and cable in hand, mission specialist Janice Voss floats through the access tunnel into SpaceHab, a laboratory module carried on the space shuttle that housed a wide variety of experiments.

PHOTOS: NASA



ering and the mixing of a cryogen.

SHOOT, which was housed in its own container in the payload bay, also offered Voss the opportunity to use her hard-won MIT expertise by operating the Remote Manipulator System—the shuttle's robotic arm. Guidance and control was her thesis area, and operating the arm is nothing if not an exercise in control. "SHOOT had been leaking some helium and they wanted to take a look," she recounted later. "I went down along the front of SHOOT and stretched the arm out and cradled it into the bay. The training program was excellent: the arm worked just like the trainers said it would."

The data from these studies take time to analyze fully, and the astronauts are usually out of the loop by the time the final reports are made. But Voss reported that the investigators to whom she spoke soon after the flight were "very excited about the preliminary results." When these experimental processes are understood and procedures have been defined, fully automated space-production facilities could be designed to fly on a number of platforms, such as recoverable capsules launched on expendable boosters or untended shuttle payloads.

The Mind of an Astronaut

Madeleine L'Engle's science fiction book *A Wrinkle in Time*, which Voss found in the public library when she was in sixth grade, sowed the first seed of her space career. "Being an astronaut was just the top of the list of things I thought would be fun to do. By college I knew that the space program was where I was going to be—one way or another." Earning both a master's degree (in 1977) and a PhD in aero/astro from MIT were steps along a well-planned path to her goal.

Enthusiasm has always been one of Voss's trademarks. Reporters expecting the staid demeanor of a typical astronaut were caught off guard when she literally "jumped for joy" on arriving at Cape Canaveral with the STS-57 crew for the final flight preparations. "I'm so excited to be here!" Voss bubbled. "It's going to be a great flight." Photos of Voss a good foot in the air were printed in newspapers across the country.

Given the risks of the job, some people find such excitement hard to understand. "Aren't you afraid?" is one of the most common questions astronauts are asked. Voss responds: "Almost everyone has known of people killed or injured in car wrecks, but do you fear for your life every time you get in a car? No, you decide that you need to drive more than you want to avoid the risk of getting killed in a car crash, so you do it and stop thinking about it."

The lack of anxiety exhibited by Voss and her colleagues owes much to their intensive training in simulators. "I got up there and discovered that very few things felt like you were doing them for the first time." All the first-time jitters had already been worked through. Even the launch seemed familiar. "They take us out to Brooks Air Force Base and run us through a centrifuge that has a launch [gravity] profile, so even that isn't a surprise. In fact on launch morning, I was so relaxed that I worked in a 45-minute nap in the free time I had."

For Voss, a mission specialist on the mid-deck, with no windows to look out of and no ascent responsibilities, the launch was actually a bit anticlimactic. "The orbiter is a very smooth vehicle. You lift off at just a G and a half, not enough to really be noticeable. You're far more aware of the fact that you're lying on your back than that you weigh a little bit more than normal. It builds very smoothly up to two and a half G's, drops back down to one G, then builds very smoothly to three G's. The helmet filters out a lot of the noise. The craft vibrates quite a bit, but it's like riding the Green Line out to Haymarket on the old tracks."

Still, there were some surprises in orbit. For instance, "Being in space is not experienced as 'floating,' at least not for the first couple of days," she reports. "It is experienced as being much in the position that you are in on the pad, because what your body notices most is the fluid shift toward your head. So it feels like lying on your back with your feet in the air, even after you unstrap."

One of the things a first-timer worries about is SAS: space adaptation syndrome—in the vernacular, "space sickness." Susceptibility varies widely, and there are no tests available on the

Voss's apparent serenity as she heads toward the Endeavour *for lift-off was for real. Confident that everything would go exactly as it had in training, she took a 45-minute nap on the morning of the launch.*

ground to predict how a given individual will react in space. "About 80 percent of astronauts experience some symptoms, which could be just a headache from the fluid shift, and some 20 percent get severe symptoms," Voss explained. "I didn't have any symptoms at all, which was a wonderful bonus."

One of Voss's most moving experiences on her flight was the retrieval of EURECA—the EUropean REtrievable CArrier—which had been gathering data on a number of microgravity experiments since July 1992. "I was by myself in the SpaceHab module, which had an overhead window, and the lights were darkened, so I could look out and monitor EURECA's approach. I watched EURECA grow from a tiny star to a full-sized satellite with the Earth as a backdrop. Looking through the viewfinder of a camcorder, the satellite and the Earth filled my vision. Since you're sort of floating, you don't experience the orbiter around you; you feel like you're out there in a universe all by yourself. It was just EURECA and the Earth and me, listening over the headset to Commander Ron Grabe as he flew a perfect approach. Unforgettable."

Beyond the Right Stuff

Living in a confined space for a week with five colleagues, all under pressure to work quickly and accurately, is a challenging job. The consequences of a foul-up range from the modest to the serious—embarrassment before millions of TV viewers to loss of the vehicle and crew. Voss found that the willingness and ability of crew members to help each other out makes a big difference.

That aspect of being an astronaut seems at odds with the lone-wolf conception portrayed in the popular media. "I think the 'right stuff' image is pretty heavily distorted," Voss says. "There is a spectrum just like in any other group. The folks in the astronaut office are all smart people, they're fun to talk to, they're fun to work with, and one of the things I most enjoy about the day-to-day aspects of being an astronaut is working with that group of people. It's really very much like being in the Space Systems Lab at MIT in graduate school, and that's a big plus."

(Aspiring astronauts might note that the Space Systems Lab was disbanded by MIT in 1990, and the personnel relocated to the University of Maryland.)

When it was time to land, the astronauts stuffed themselves into their launch and entry suits and started fluid-loading—drinking large quantities of salty water, which helps to minimize the medical effects of returning to Earth. They were ready for their de-orbit maneuver, only to be waved off due to bad weather at Cape Canaveral for two days running. In an emergency, *Endeavour* could have landed at Edwards Air Force Base, but to avoid the roughly $1 million cost of transporting the orbiter from California back to Florida, mission controllers elected to wait one more day to see if weather at the Cape would improve.

The experiments had been powered down, and the crew found themselves with an unusual commodity in space—free time. After preparing for landing and then re-configuring the spacecraft for orbit, they found about four hours of freedom each day. Voss had actually brought along a book, and she curled up under a flight deck overhead window to read Isaac Asimov's *Foundation* (an old favorite) by Earthlight. Owing to their three successive days of landing preparation, the STS-57 crew were the all-time champions of fluid-loading, contributing to an unusually quick re-adaptation to gravity.

Was flying in space everything Voss had dreamed of? "It was very much like the experience I had in getting into the astronaut program. Everything I was worried about turned out not to be a problem, and everything I was looking forward to was even better." Given the flight rates and the makeup of the astronaut office, Voss thinks she might have as many as 10 flights before she retires.□

RUSSELL HOWARD, PhD '90, is associate director for flight and test operations at the University of Maryland's Space Systems Laboratory. David Akin, '74 and ScD '81, now a UM faculty member and director of the UM Space Systems Labortory, made significant contributions to the article. While he was the director of MIT's Space Systems Laboratory, 1981–90, Akin was the doctoral advisor for both Howard and Voss.

A Letter from Richard A. Jacobs '56

Minding the Store

Sensitivity is indispensable for today's administrators. All their decisions must be made with individual, group, community, and environmental interests in mind. Conventional wisdom suggests that success comes with rallying these separate interests to a common cause. But conventional wisdom, unfortunately, hasn't had to deal with the depth of disparity and inflexibility that confronts managers of institutions such as the modern university. Accomplishing the simplest of tasks now consumes enormous amounts of energy, time, and resources.

President Charles Vest captured it well, I believe, in his report for the 1992–93 academic year (*see page MIT 51*). "We must find ways to deal with the fragmentation, both intellectual and social, that has accompanied change," he enjoined the MIT community. "We need a vision that embraces the complexities of our times while helping us to move toward greater coherence around common goals."

To me, this means minding the store. The priority goal for the president is helping each individual realize the dream of higher education—providing the opportunity and delivering the knowledge that every student needs to succeed. Did any of us arrive at the Institute with a lesser expectation?

The most important change to which the president refers is that the population of this campus is no longer homogeneous. A rich mix of backgrounds was clearly visible in the faces I saw as I walked to his office for a meeting on August 25th, the day before the opening of freshman orientation. But the 18-year-olds who clogged the halls were very much alike in their luggage and backpacks, their expressions of awe and even apprehension. Each had begun the process of realizing his or her dream of an MIT education.

On this occasion, his address to the freshmen was clearly on Chuck's mind. What should he say? We both laughed and talked about the imaginary college president who struggled with this same

predicament in Gary Trudeau's *Doonsbury* comic strip: The speech writers and legal advisors examined the draft of his talk and removed every reference that wasn't absolutely politically correct. The speech, in its entirety, went something like, "Members of the class of 1997, welcome. Thank you." But for Chuck, appreciating the humor of his situation didn't make any easier the task of drafting an address that would speak to the priorities and values of all the incoming students.

Today's enrollment contrasts dramatically with my years, when the number of women was very low, and the men were overwhelmingly Americans of European descent. In 1992–93, as the president notes in his report, women comprised 33 percent of the undergraduates and 23 percent of the graduate students; 40 percent of the undergraduates and 9 percent of the graduate students were members of U.S. minorities; and international students made up 9 percent of the undergrads and 34 percent of the graduate students.

Those obvious factors are only the beginning. In talking to these young men and women, you know they have minds of their own, something to say, and a degree of independent thinking that is stronger and different from their predecessors. Today's faculty members are similarly diverse, with their own agendas. It is a time of entitlement, and my entitlement is different from yours. Trying to bridge the difference is no easy task.

The critiques of every action or statement of the president come from the politically correct on both left and right. I remember working on telethons in the late sixties, when every alumnus I called who was cutting his donation to the Alumni Fund because of the Institute's inaction concerning the Vietnam War would be countered by an alumnus who was not giving because he thought the students and faculty were too politically active!

The campus faces real problems, important from every perspective, all needing redress. But if you ask a mix of 100 students, faculty, administrators, and support professionals for their views on any issue, you will probably receive 100 different answers. There is a way to find one single solution equally satisfying to everyone. It's called pablum: making decisions so compromised that little value is generated. Orsen Wells, in *The Third Man,* remarked that the Swiss did everything safely and with compromise for 350 years and only produced the cuckoo clock. He exaggerated, of course, but the point is, pablum is not what we expect of MIT. Graduates of MIT aspire to be leaders in science and technology, and this means sticking your neck out. Certainly we need to concern ourselves with what is right, but that's different from trying to do what is only politically correct. Answers that satisfy everyone are simply not the stuff of leadership.

Chuck Vest is right, in his report for the 1992–1993 year, when he notes that we need to value, celebrate, and build on our differences, but also to discover and renew our mutual commitment to the shared values of academia. We must have community. We must have mutual respect. We must have common purpose. Chuck knows how to mind the store. Consuming energy, resources, and time for a lesser goal is not in the MIT tradition.

Best wishes,

Richard A Jacobs

Richard A. Jacobs, '56, President, Association of Alumni and Alumnae of MIT

PHOTO: J.D. SLOAN

CLASS NOTES

19 75th Reunion

As you probably know, we have recently lost four classmates. I will write about them in the next issue, but for now a few lines on two who are still living.

Did you know that the Japanese haiku is a three-line poem comprising five, seven, and five syllables. I didn't know until **Bob MacMullin** of our class told me, so I share my new knowledge with you:

Algy met a bear,
The bear was bulgy, alas
The bulge was Algy.

On September 18, Bob was 95 years old. He takes daily walks to keep limber. Call him in Lewiston, New York, (716) 284-1861, to learn more.

Another classmate has outdone me in cutting grass. He cuts five acres in two and one-half hours. I cut two and one-half acres in two hours. Without my MIT slide rule, I agree he is ahead of me, but I am somewhat older than he is. He does, however, deserve credit: **Francis Weiskittel**, 6909 Bellona Ave., Baltimore, MD 21212. He would enjoy a letter from you and can tell you about much more than grass cutting.—**Bill Langille**, secretary, Box 144, Gladstone, NJ 07934

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Please send news for this column to: **Harold Bugbee**, secretary, 313 Country Club Heights, Woburn, MA 01801

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If there were an honor award or a Most-In-Touch Club to recognize loyal alumni/ae with top attendance records for Technology Day (former Alumni Day) and our quintennial reunions, **Frank H. Whelan**, civil engineering, who lives at 1980 Commonwealth Ave., Brighton, MA 02135, probably would head the list for the Class of 1921.

In past years, Maxine and your scribe always have known we could expect a cheery greeting from Dinnie on our annual trek back to Tech. We also know of his pride in significant church posts achieved by two sons and that one of them served for years in Rome.

When last year's papal visit to the U.S. was announced, your secretary wrote to Frank to ask if he was looking forward to a visit from a member of the entourage. A prompt reply tells us that Father Frank, Jr., S.J. is a priest in the Jesuit Order and "assigned coast to coast in Canada."

It also notes that Father Joseph Whelan, S.J., never was attached to the papal staff. On receiving a doctorate from Queen's College in England, he returned to this country and was appointed Jesuit Provincial for the Maryland Province. Then the general of the order appointed him as his assistant for the entire order in the U.S., and he was stationed in Rome for seven years.

We have a most heart-warming card with notes from Leila and **Sam Lunden**, assistant secretary, which recall "our many enjoyable visits with you and Maxine" on Technology Day and in their lovely California home. Sam reports hearing indirectly of the death of **John B. Baker**, engineering and business administration, in 1992, but says he has seen no official confirmation. John was a former chief engineer of Timken Roller Bearing Co., and had retired.

Since there has been confusion as to attenders at our 70th Reunion in 1991 at MIT, we will attempt to set the records straight. If memory serves correctly, here is a list of 11 persons at the luncheon in the Athletic Center. If you disagree, please notify your secretary of changes. There were three members of the class—in alphabetical order—**Carole A. Clarke**, electrical engineering (class president), whose guests were his wife, the late Maxine M. Clarke, and their son and daughter-in-law, Alfred L. Clarke and Marie H. Clarke; **Benjamin Fisher**, mechanical engineering, with his wife, Mary Fisher, and **Roy D. Snyder**, electrochemical engineering, with his daughter, Nancy S. McCumber, and her husband, Mr. McCumber.

Also in the party were Mrs. Harry M. Myers, wife of the late **Harry M. Myers**, chemical engineering, and our reunion hostess, Janet L. Serman of the staff of the Alumni/ae Association.

As your belated—but most welcome and very highly appreciated—Christmas gift, please write or phone us about yourself and family for use in this column.We need help! Now! Please!—**Carole A. "Cac" Clarke**, secretary, 608 Union Lane, Brielle, NJ 08730, (908) 528-8881; **Samuel E. Lunden**, assistant secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

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To my classmates of '22: This is to inform you of the death of **Harvard E. Moor** (July 21, 1993) who spent 50 years of employment as an electrical engineer. Following in Harvard's footsteps, his grandson, Bruce Peacock, graduated from MIT 60 years later.—**Martha E. Munzer**, secretary, 4411 Tradewinds Ave. E., Lauderdale-by-the-Sea, FL 33308

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Please send news for this column to: **Royal Sterling**, president, 2350 Indian Creek Blvd. W., #D-201, Vero Beach, FL 32966-5103

24 70th Reunion

We hear of the death of **Rutilio Torres-Saravia** on June 17, 1993, in Guadalajara, Jalisco, Mexico, from his son, Miguel Torres. Torres is general manager of the Sheraton Buganvilias in Puerto Vallarta. This is all I know of the family, but anyone out there who would like to give me more information about Rutilio, I will be happy to put it in this column. Our sympathy to the family at this time. A note from **Henry Stern** informed me of the death of **Herbert W. Kochs** on June 5, 1992. He passed away at this home in Sunnydale, Berkshire, England. He was the founder of the Diversey Corp., a multinational industrial chemical manufacturer headquartered in Chicago. Henry also said that Herbert Kochs was a past president of the MIT Club of Chicago and a director of the National Council on Crime and Delinquency and several other clubs in Chicago. He was 90 years old. Condolences to the family.—Co-secretaries: **Katty Hereford**, 237 Hacienda Carmel, Carmel, CA 93923; Col. **I. Henry Stern**, 2840 S. Ocean, #514, Palm Beach, FL 33480

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The latest class listing was prepared by the Alumni/ae Association in August 1993. There are 89 members of the Class of 1925 for which addresses are useable. There is the same large number for which no addresses are available.

Two changes may be of interest to classmates. **Conrad Berman** has moved from Pompano Beach, Fla., to 224 Kennedy Dr., Malden, MA 02148. . . . **Arthur Sharp** has left Providence, R.I., for 208 48th Ave., W. Bradenton, FL 24207. . . . Last year the names and addresses of eight classmates residing outside the USA were reported. This year mail is not being delivered to **Theodore Durrant** in London or to **John Sutcliffe** in Costa Rica. No word has been received from these classmates.

It is with sorrow that the passing of **Rufus N. Palmer** must be reported. He died in Pittsburg, Pa., on July 3, 1993. Rufus and Ruby were attendees at most of the class reunions but were unable to make the 65th. Rufus went to industry upon graduation but returned to the Institute from 1934 to 1937 to earn a doctorate. From 1937 to 1947 he was with the Mellen Institute of Industrial Research. In 1948 he set himself up as a consulting engineer, then in 1951 established his own company, Palmer Magnetic Separator. Rufus held five patents on magnetic separators and pearl button cutting machinery. Rufus's wife, Ruby (Spence) Palmer, survives him.—**F. Leroy (Doc) Foster**, secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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I'm sorry that I have nothing but obituaries to report in this issue.

Alexander C. Wallace of Salt Lake City died May 17, 1992. Upon graduation from MIT he went to work for Hope Engineering Co. of Florida. After World War II, where he served as a lieutenant commander in the U.S. Navy, he joined his father in business and was VP and sales manager for the Utah Oil Refining Co. before it merged into American Oil Co. He traveled extensively with his father, who was chair of the Utah Water and Power Board. He is survived by his widow, two stepsons, and others.

Joel S. Tompkins of Asheville, N.C., formerly of Salem, Mass., died April 3, 1993. He was the son of the founder of Tompkins Furniture Co. in Salem. He retired from Alcoa in 1970. He was a member of the Asheville Symphony and the Committee for the Friends of Chamber Music in Hendersonville. He was inducted into the "Second Wind Hall of Fame" in 1981. He is survived by his wife, Helen Freeman, and a son, a brother, two sisters, and two grandchildren.

Dr. **Peter L. Bellaschi** of Portland, Oreg., formerly of Fitchburg, Mass., died May 21, 1993. He was a pioneer in the electrical power industry for 60 years and worked with Westinghouse Electric Co. In 1937 he was given the Westinghouse Order of Merit. From 1947 through the 1980s, he was a private consultant to electric utilities, federal agencies, and electric equipment manufacturers throughout the world. He was the U.S. adviser on international standards for many years and received many awards. He leaves two sons, two daughters, eight grandchildren, and others.

Robert T. Dawes of Hudson, Mass., died May 26, 1993. He was a former treasurer and chair of the board for Thomas Taylor & Sons, with whom he was associated for 67 years. During World War II, he wrote all the government specifications for narrow textiles that were used in life-support apparel and systems. He served on the board of directors of David Clark Co. in Worcester, Mass., for many years. He was a part owner of New England Tape Co. in Hudson and held many patents. He was also associated with the Hudson National Bank, the Board of Governors of Marlboro Hospital, the Boy Scouts of America, Doric Lodge of Masons, and the Hudson Boys Clubs. He is survived by a daughter and two granddaughters. . . . **Benjamin Margolin** of Cambridge, Mass., died June 9, 1993. He is survived by his wife, Ruth.

John Vernon Masterman of Needham, Mass., died June 30, 1993. He had worked for more than 31 years as branch engineer in Boston and New York for the York Corp. of York, Pa. He had many professional involvements. In 1958 he resigned from York Corp. to join two of his MIT classmates at St. Onge, Ruff Associates, consulting engineers in York, where he remained active until age 80. His consulting work for the Atomic Energy Commission led him to many parts of the world, including Havana, Tehran, Beirut, Rome, and throughout the U.S. and Canada. He worked on the Manhattan Project and on major projects for the U.S. Air Force. He is survived by his wife, Hazel Peterson, and a daughter, a son, ten grandchildren, and four great grandchildren.

Ronald J. Martin of Elizabethton, Tenn., died July 9, 1993. He was an electrical engineer, retiring from Beauknit Corp. as a power engineer. He was a member of the Masons. He is survived by his wife, Hazel, and a daughter, son, and two grandsons. . . . **George A. Booth** of Worcester, Mass., died June 29, 1993. Before retiring 20 years earlier, he had been sales manager for George F. Wright Wire and Steel Co. for 25 years. He was a member of the Auburn Play Readers, the Converse Lodge of Masons, a charter member of the Auburn Historical Society, and a member of the board of trustees of the Auburn Public Library for 30 years. He leaves his wife, Margaret, and a son.

Please send news to—**Donald S. Cunningham**, secretary, Eventide, 215 Adams St., Quincy, MA 02169, (617) 328-1840

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Frederick W. Byron died July 12, 1993, in Amherst, Mass. He received an additional BA from Harvard Business School in 1931, after serving a couple of years with Bethlehem Steel Co. He worked for the Massachusetts Department of Public Works between 1933 and 1935. A civil engineer, Fred started his own construction contracting firm in 1935 in Dedham, Mass., and continued in this profession for the rest of his career. He has traveled to Europe and Central America, attended our 20th and 50th Reunions, and joined the group at the Cardinal & Gray meetings at Endicott House in Dedham.

Carleton P. (Pub) Whittier died August 18, 1993, in a nursing home in Perrysburg, a suburb of Toledo. He is survived by his wife, Ruth, three sons, and seven grandchildren. He had a distinguished career and was a very loyal MIT classmate. After graduate work at MIT, he joined the Research Department of Congoleum Nairn, Inc., moving to Marcus Hook as assistant works manager in 1929. In 1934, he joined the Packaging Research Division of Owens Illinois Glass Co. in Toledo, became manager of the Equipment Division in 1939, and in 1951 became manager of Customer Service, where he continued until retirement in 1969. In 1966 he was the recipient of the Outstanding Contribution to Packaging Education award presented by Michigan State University. An excerpt of the award: "Mr. Whittier is now responsible for solving the technical problems relating to the preservation and shelf-life of products packaged in glass, including the planning of glass packaging lines for customers and development of special mechanical equipment where it is not commercially available." He was a national authority on glass packaging.

Pub Whittier

In old notes we find his words: "I was put out to pasture on December 31, 1969, amid an embarrassment of compliments, kudos, gifts, and eatables galore. Within 10 days I was on a plane to Venezuela on a consulting job for Owens Illinois International Division—an interesting country with some very friendly people. In February, Ruth and I flew to Madrid, where I began another consulting job with a Spanish subsidiary." As a retired consultant, Pub was associated with his classmate **Dick Cheney** in the development of his speed packaging facility for the beer and soft-drink industry. Dick was managing director of the Glass Containers Manufacturing Institute.

Pub was a member of the Packaging Institute, Ohio Society of Professional Engineers, and the Toledo Technical Society. His loyalty to MIT was evident as president of the Toledo MIT Club and his attendance at every reunion of his class from the 20th. We extend our deep sympathy to his wife, Ruth, and their large family.—**Joseph C. Burley**, secretary, 1 Harbourside Dr., Delray Beach, FL 33483; **Lawrence B. Grew**, assistant secretary, 21 Yowago Ave., Branford, CT 06405

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Post-reunion matters seem to be the only news these days. While there were cameras carried by a few classmates and guests at the reunion activities, it was an oversight that there was no official picture scheduled for this special occasion. Furthermore, the entire group was not together at any one time. But after our class dinner at the Faculty Club on Friday night, combined with the Class of '33 to take advantage of the opportunity to meet with President Vest, two cameras present recorded two settings—one of the 19 of the 24 classmates who had attended all or part of the events and another of these 19 plus 16 guests. Several almost identical shots were taken, probably because everyone was in prime condition to remain immobile after a busy four days.

Copies of the pictures will be sent to all those on the list of registrants. Others may get copies by request to your secretary. The only charge is a news item for Class Notes.

Half of the men wore their 50th Reunion cardinal jackets, which enhanced their gentlemanly appearance, but the comeliness of their wives and guests did not need such adornment.

We can note with congratulations the full-page picture of our class agent and treasurer **George Palo** in the October 1993 *Technology Review* as a participant in the MIT Life Income Fund Program. We must ask him if the position of his hands on the fish pole indicates the length of "the big one that got away."

It is a pleasure to have no reports of deaths this month and we hope that you stay well and comfortable during these colder seasons.—**Ernest H. Knight**, secretary, P.O. Box 98, Raymond, ME 04071

29 65th Reunion

I have a note from **Henry F. Robbins** (wife Anne), Gillette, N.J., as follows: "We are glad to hear that you are better now, as far as your eyes are concerned. During physical examination prior to my cataract operation, the doctor listened to my heart and asked me if I was an athlete? I replied, 'Not exactly, but I run up and down the stairs a lot.'". . . **Kenneth D. Beardsley** (wife Barbara), 30 Pleasant St., Dalton, Mass., writes, "We just celebrated my 84th birthday. We have been married 57 years. We are happy to be living in the beautiful Berkshires. Retired as organist at Zion Lutheran Church in Pittsfield. I have attended Tanglewood and served as volunteer since 1935. Gardening is my primary hobby plus camping, music, and photography." They have two children and two grandchildren.. . . During the last 18 months when I had my eye problem and could neither write nor read, my good friend and classmate, **Richard E. Bolton** of Westmound, P.Q., Canada, kept writing

and wondering why he got no reply. From his letter: "This has been a horrible winter, which brought the worst snowstorm in 10 or more years. I am too old for this kind of weather, and lack of exercise has caused my arthritic back and ankles to give me trouble. I am getting ready for Spring by discarding old clothes and shoes that no longer fit me because of swollen ankles. Also had my trousers let out for my granddaughter's wedding in June. Easter week will see me on my way to Toronto to see about a suitable wedding gift. The wedding will take place at the Presbyterian Church of Hillsburg, Ontario (population about 1,200) with a reception at her family home nearby.

I regret to announce the passing of the following members of our class: **Wayne F. Koppes,** January 29, 1992; (Mrs.) Helen **Walther,** October 4, 1991; **Butler King Couper,** June 18, 1993; and **Hans K.R. Witschel,** June 14, 1993.

Witschel, 88, of 10 Hoffman Ave., Methuen, Mass., worked as a payroll analyst at the American Woolen Co. until his retirement. His job took him all over New England. He was a member of the Bavarian Club and the Wednesday afternoon Old Timers Club. He is survived by his wife of 52 years, Mary (Hennessy), and several nieces and nephews.

Couper received an SB from MIT and an MS from University of California, Scripps Institution of Oceanography, in La Jolla in 1948. He was commander oceanographer of the Bureau of Ships, Navy Department, Washington, D.C., and retired in 1972. He served in World War II and attained rank of commander, USNR. He was a life member of Alpha Epsilon Fraternity, a member of St. Andrews Society, American Geophysical Society, American Geophysical Union, Marine Technology Society, and the Cousteau Society, all in Washington, DC, and the Institute of Oceanography in Miami, Fla. He was also a former director of Tryon Rotary Club, a member of Tryon Riding and Hunt Club, and Polk County Historical Society. He was a ham radio enthusiast and attended Philadelphia Presbyterian Church in Landrum. Surviving is a brother-in-law, John W. Haney of Tryon, also several cousins.—**Karnig S. Dinjian,** secretary, P.O. Box 83, Arlington, MA 02174, (617) 643-8364

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This month's Notes will necessarily be quite brief because Louise and I are in the throes of moving from our condo in Southbury, Conn., to Williamsburg Landing, a life-care facility in Williamsburg, Va. We plan to become legal residents of Virginia but for the present will keep our Green Valley, Ariz., home for winter living. The few items that have accumulated will be reported in the next issue. Our new address is given below.—**Gordon K. Lister,** secretary, 5707 Williamsburg Landing Dr., Apt. 40-D, Williamsburg, VA 23185

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Was startled to receive notice of the death of **John MacBrayne, Jr.** "Mac" died at Penobscot Bay Medical Center, Camden, Maine, on June 11, 1993, after a brief illness. He was born in Quincy, Mass. After graduation he remained at MIT for several years as an assistant instructor. He then embarked on a career as an engineer, primarily in the pulp and paper industry. He was listed in *Who's Who in the East* in 1974–75 as well as in *Engineers of Distinction.* He was named a Tappi Fellow of the pulp and paper industry and a Paul Harris Fellow of Rotary International.

During World War II, he served in the Bureau of Ordnance as a Navy lieutenant in Washington, D.C. He joined Union Camp Paper Corp., where he spent the rest of his career, moving to Savannah, Ga., and later to Mountain Lakes, N.J., where he served on the borough council for nine years, six as its president. His other activities included president of the Camden Rotary Club and president of the Camden Public Library board. In Mountain Lakes he served on the vestry of St. Peter's Episcopal Church, and in Savannah he was chair of the United Fund, Special Gifts, and a member of the board of the Boy Scouts of America and the Children's Museum. He was chair of the Engineering Division of the Technical Association of the Pulp and Paper Industry, serving as well on many other committees.

Surviving are his wife of 52 years, Sally Hubbs McBrayne; a son, John M. MacBrayne III; a daughter, Pamela MacBrayne Moonan, and a very special grandson, Tavis MacBrayne Moonan; a sister; and several nieces and nephews. Informal memorial services were held July 2, 1993, at the Camden Public Library Amphitheatre with arrangements by Direct Cremation of Belfast. Memorial donations may be made to the MacBrayne Family Scholarship of the Pulp and Paper Foundation of the University of Maine, Orono, ME 04473; the Camden Public Library; or the Children's House Montessori School Scholarship Fund, 63 Elm St., Camden, ME 04843.—**Wyman P. Boynton,** secretary, 668 Middle St., Portsmouth, NH 03801

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Responses, as of September 24, for our six-day mini-reunion to be held in Tucson, Ariz., April 6–11, have been encouraging. About 15 classmates have declared their interest in coming. About 25 said they cannot come, mostly due to health reasons. We urge those who have not made up their minds to do so. It will be a very nice get-together. We assure you that you will make many friends.

Ben Chadwick regrets that personal plans make it impossible to be at the reunion ("a great idea and excellent location"). Two of his daughters graduated from the University of Arizona. The Chadwicks do a lot of traveling and attend many Elderhostels.

Harner Selvidge, who lives in Sedona, Ariz., says he would gladly entertain our reunion group at his home, which would include one hour of popular music performed on a theater pipe organ. He also would assist the chartered bus guide in a tour of Sedona. Thanks, Harner, maybe we'll do as you suggest!. . . **G. Robert Klein,** of Cleveland, Ohio, and his wife, Mary Elizabeth, are providing funding for three new compositions to be performed by the Youth Orchestra of the Cleveland Orchestra. The works will be by young composers (ages 15–25). I am continually surprised how often our classmates are active in the arts field. . . .**Tom Weston** and **Arthur Marshall** and spouses are traveling at every opportunity. This past summer they were on a six-day cruise about the Islands of Cape Cod and a stop in Newport. Now Arthur is touring beautiful Switzerland—then he goes to Israel for the umpteenth time.

Willem ('32) and Mary Holst, photographed at Tijuca Forest in Rio de Janeiro, Brazil, during a three-week South American cruise in November of 1992. In July they will celebrate their fifth wedding anniversary.

We have just learned that **Howard M. Quigley,** a nationally recognized leader in education for the deaf, has died. He was active in civic and religious organizations. His wife died in 1980, and his son was a cancer victim at 37.

Keep writing . . . *anything.*—**Melvin Castleman,** secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Heading the class news just in . . . **Wilber (Bill) Huston,** our new class president, took off with wife Dorothy soon after they attended her Class of '41 reunion at Lees-McRae College in North Carolina. They left on a three-week trip to the seclusion of the British Isles—Glasgow, York, and Cardiff. Bill and Dot have been married 47 very happy years. Bill hopes to see more of us at our mini-reunion this year. Let's all be there!

John Longley informs me that he and wife Lillian were at the 60th Reunion but did not make the Technology Day activities in Cambridge. This caused them to miss being photographed with the rest of us. However, John treasures that picture so highly that he has it on view in the front entry of his home along with the 50th Reunion class photo. John assures us that he definitely will make the class photo for the 65th. He enjoyed reading the "bios" in the Class Book, but wants to correct his own on two counts, so that posterity will not be misinformed: 1) There is an omission in the sentence "Tucker [name misspelled], Morse, Magoun, and all, [but golly it would make a long list. Freshman English with Green was] one stumbling block." And 2) the correct date of his joining the Signal Corps Reserve is 1929, not 1939. Beyond this he is not making waves but hastens to elaborate on wife Lillian's ascension in the representations of gar-

dens in her paintings and pastels—her work is in the permanent collections of KeyCorp and Manufacturers Hanover (Bank). Gardeners everywhere will be delighted to have their fast-fading seasonal treasures put on permanent display for all to enjoy. Nice going, Lillian and John.

Although he was born and raised near Boston, **Phil Coffey** says his being at our 60th marked his first return to New England in 52 years. He was astonished and delighted by the serene beauty of the campus that contrasted with the sere and Spartan aspect he remembered from the 1930s. He went on to compliment the Reunion Committee for a thoughtful and well-executed program.

Phil's distinguished career began after he graduated in civil engineering when he joined the U.S. Public Health Services as a captain, and then became a lieutenant colonel in the Army Corps of Engineers from 1942–46. Honorably mustered out, he held two important positions with the State of California, first as regional supervisor of the San Francisco Department of Finance (1946–49) and later as supervising hydraulic engineer for the Department of Water Resources. (1951–57). The U.S. State Department also latched on to Philip for technical assistance missions—to Paraguay (1949–51) and Ethiopa (1957–61). Then most admirably after retirement, he earned an MA in journalism from the University of Colorado. Subsequently he was elected into KTA, the national journalism honor society. Currently Phil is active in the local Retired Officers' Association and is a member and part-time instructor in the Sun City Spanish Club. Sure hope he returns to his roots in Boston before too long, possibly for the mini-reunion this year now being talked about.

Although at the 60th Reunion and in the Class picture as well, **Fred Roetting** writes to say how pleased he was to renew friendships with so many of his classmates, and how much he enjoyed the bus trips and particularly the MIT night at Pops. Fred's career after MIT began inauspiciously with factory jobs in several different venues before he caught on with Metropolitan Life in New York City from 1936–41 and again from 1946–53, where he served in the Actuarial Math Section, the Tax and Statement Bureau, and as an internal auditor. The period from 1941–46 was Fred's active duty with the U.S. Army as 2nd lieutenant through major in the Water Transportation Corps, as marine maintenance engineer, and as a transport commander aboard ship in the Pacific.

Moving to Florida because of his wife's health, Fred had a varied career before work with North American Aviation at Cape Canaveral, Fla., in Downey, Calif., and the Kennedy Space Center, Merritt Island, Fla., mainly as planning engineer and as flight test engineer for the Navajo Intercontinental Missile program and the Apollo Moon program, as well as Skylab. Although he is now retired, he is very much involved with human health services as a volunteer, in-hospital patient care, hospice service, and visitations with the home-bound. Fred's wife passed away in 1961 after fighting rheumatoid arthritis valiantly for many years. A world traveler, Fred has been to every state except Hawaii, which he expected to visit this past October. Another contributor to humanity from MIT and a great credit to the Class of 1933.

As though I were not taken enough by **Norm Spofford** at the 60th and the way he so graciously smiles at every meeting, he makes me even happier by writing at my urging to enlarge on his brief biography in the Reunion Class Book. As mentioned therein, beginning as a co-op student in Course I-A, he went from civil to mechanical and finally to nuclear engineering in many capacities. While he was with GE he worked on the design and testing of a nuclear aircraft engine, and part of the time designed tests for a secret satellite observer. Then on to Westinghouse, where he was involved with design and testing of a nuclear rocket. Retiring, as he says, he worked on salt-water purification for ships for several small firms. In Japan for a time, Mitsubishi contacts led to permanent affiliations in Taiwan, where he now spends four to six months of the year. Norm was planning to be in Taiwan by the end of September. He has had no contacts with close classmates after graduation with the exception of **Wendell Allen** (also I-A), with whom he communicates occasionally since they are both Floridians. I do hope to hear from Wendell as soon or sooner than I hear from Norm. Happiness to both of you!

Before all fades away in memory, the 60th Reunion was a smash—everyone made it so. Though not all-inclusive, the following impressions of classmates may serve to make the Reunion somewhat more memorable:

Bill Huston, whom I met first off in the hallways of McCormick, was a delight. Bill's contagious smile and unobtrusive style will serve us well as our class president (I could have foreseen his coronation). Bill can hit it off with anyone as he did with me. . . . Cheers to **Herb Grier** for his magnanimous funding of the Herbert E. Grier Room in the EG&G Building

and for his obvious addiction to bowties over the years (see 25th Reunion photo). . . . **Cy Hapgood,** in his patent-attorney way, delivered punchlines hysterically and spontaneously at the Lobsterfest Banquet. . . . **Dick Fossett** relentlessly oversaw every detail, as he and Charallee hosted almost everything. . . . **Ben Liberfarb** could teach Patrick Swayze a thing or two. Not only can he dance, but he is a charmer as several young ladies found out.

Larry Parsegian, whose scholarly bearing could not conceal his obvious pleasure being here with wife Varsenig, only lately acknowledged that we are not-too-distant cousins. . . . **Steve Rhodes,** the Nominating Committee chair, knew that the new class officers would not only serve but would never be DOA. . . . **Ferd Johnson** carpentered the staging of the Reunion as chair of the Reunion Committee. . . . **Mal Mayer** would make a great portrait and I had to say so to his face. . . . **Bill Klee** got off easy by saying he could no longer keep up as class secretary because of his age (thanks anyway for the job at my age). . . . I recognized **Len Julian** from a previous reunion and met his wife, Doris. We found mutual friends and acquaintances so long as we kept talking. . . . **Charley Britton** is the one and only class officer to serve another five years in the same treasury office. Ominously his Treasurer's Report said he was about to go on vacation but did not say where or when. . . . **Joe Dysart** and wife Veronica from fantasyland California politely listened as I read a James Michener quote touching on the luckless yet idealistic college graduates of the 1930s. . . . **Wern Bachli** concealed the fact that he can sing behind that face so magnificently bearded. . . . **Neil Hopkins** seems to be another shipmate who can sing a sea chantey or two now that we've found out he was a baritone soloist back home.

Charlie Fulkerson thought he could authenticate having the "Youngest Child of the Class" by sending along a photo of his wife and four children at the ages of 17, 14, 11, and 1 for inclusion in the 25th Reunion Class Book. Well, he authenticated that Heidi, the 1-year-old, is pretty precious as well by appearing with Dad for our 60th. . . . **Clare Farr** is the guy you can look to as a brother and who acknowledges that he will play the piano just for the asking. . . . **Ivor Morgan** seemed to have the largest family representation at the Reunion and a very personable and wonderful family indeed. . . . Last, and not intentionally leaving anyone out, I come to **Ed Simpson,** who attended classes with me in the old firetrap of a building know as Rogers and entrusted to be the School for Architects for a chosen few. I had not seen Ed in 60 years. He and wife Ida exuded happiness wherever they went as we closed out a Reunion that each of us will long remember.

Since the October '93 *Tech Review* listed the passing of **Gustav V. Liljegren** as January 24, 1992, and since his wife, Peg, and daughter, Pat, had sent a brief biography for inclusion in our 60th Reunion Class Book (publication date June 1993), it seems fitting to posthumously credit this particular classmate who indeed "refused to retire." Referring to an article in the October '88 issue of the magazine *Money* (five illustrated pages), I learned that Gus came to the United States as a teenager with his naval-architect father. Like many of his other classmates, he found no steady job after graduation. However, he was hired at $25-a-week in 1938 as a photo-lab technician. Apparently that subsistance encouraged Gus to marry Peg, daughter of a Unitarian minister with a Radcliffe degree in chemistry. The chemistry was right since one year later Gus began his first 35 years as a mechanical engineer with GE. The last 10 years before retiring at the mandatory age of 65, he became a specialist in marine propulsion systems working on everything from ferries to nuclear submarines. Thereafter Gus was a consultant specialist on gears principally with the Coast Guard in San Francisco, Seattle, Ketchican, Kodiak, and Nome. His most exciting project was a 15-day trip on the icebreaker *Polar Star* checking the great stress on the main gears crashing through thick ice from Dutch Harbor to Nome. In the *Money* article, he said his toughest job was six weeks spent rejuvenating twin bull gears in an old WWII British aircraft carrier on site for the Brazilian Navy. Each of the gears was 13 feet in diameter and almost hopelessly rusted. Gus described to *Money* reporters having to use sign language to communicate with Portuguese-speaking machinists and working 12-hour days in midsummer heat, commenting, "Nothing has matched that." Only five days after a colon operation, Gus left this world knowing that all his jobs were complete. The title of the *Money* excerpt is "Refusing to Retire," a great tribute to a great individual.

Other classmates reported in the October *TR* Deceased List are **Calvin H. Mohr** of Columbus, Ohio, who died on May 8, 1993; **John Stuart Patterson** of Schenectady, N.Y., on May 21, 1993; and **William L. Sorenson** of Peoria, Ariz., on May 28, 1993. Please be reminded that *all* information past or present about any of our classmates from any source is most welcome for future inclusion under Class Notes for *Technology Review.*—**Berj Tashjian,** secretary, 1245 Briarwood Lane, Northbrook, IL 60062, (708) 272-8683

34 60th Reunion

I would like to start off this set of notes on a cheerful note. I can report that plans for our 60th in 1994 are shaping up and I reproduce a summary of these plans sent to me and to **Carl Wilson** by **John Hrones:**

"The details of the program have not been finalized, but the following decisions have been made. The reunion will be held on campus June 1–5. Housing will be available at the McCormick Residence Hall. If you prefer, there are hotel rooms near the campus. Activities will include Tech Night at the Pops, attendance at Technology Day events (Friday, June 3), several tours, food galore, golf for those inclined, and, most important, an opportunity to spend some time with classmates of many years ago." The Committee promises full information in November.

Now I must turn to our losses. John Hrones and **Larry Stein** have both informed me of the death of **Charley Lucke.** Charley prepared for MIT at Brooklyn Technical High School and got a degree in mechanical engineering. He was active in many student activities and rowed on the freshman and varsity heavy crews. Most of his career was spent at American Chain and Cable Co., where he served as VP and general manager of the Wire Products Group, and the Quality Assurance Group. He laster became VP of operations and retired in 1972. He attended all of our reunions. Larry Stein, who rowed with him, has sent a long letter about their association over the many years. He refers to **Bob Emery** whom some of us remember. (I will be glad to Xerox this letter and send it to anyone interested.)

A letter from **Al D'Arcey** brings news of **Ernie DiPaolo**'s death. He came to MIT from Holten High School in Danvers, Mass. He took his degree in architectural engineering and spent most of his career as a senior project engineer with Craig Systems Corp. in Amesbury, Mass. He also worked for United Shoe Machinery and did consulting work after his retirement in 1978. He was active in the Danvers Senior Center and the local Council on Aging.

Carl Wilson sent me an article about **E. Philip Kron** ("Phil") who passed away on July 30th. I was on the freshman soccer team when he was its captain. He was 80 and passed away after a short illness. His family had long been in Rochester, N.Y., and he was at Kodak for many years. As a director of purchasing, he was known as the No. 1 buyer of industrial silver in the nation. He was president of several organizations of purchasing agents.

The local association, now known as the National Association of Purchasing Management-Rochester, named an award for leadership in the purchasing profession the "Phil Kron Award" in his honor. He was on the board of a local hospital and he served as chair and treasurer of the Rochester Area Boy Scouts of America. Phil served in the Air Force in World War II retiring from the Reserves in 1965 with the rank of lieutenant colonel.

A letter from **Walter McKay** brings news of another member of our freshman soccer team. **Wing Fong Lem** came to our 55th Reunion and told us of his life as a professor in a mainland China university. In June 1992 he suffered a stroke and was hospitalized until October. His left side is partially paralyzed. To walk he needs help and a cane. He sleeps a lot due to lack of energy, which is why he has not responded to letters from his MIT friends. His address and phone number are: Prof. Wing Fong Lem (Emeritus), c/o Aerodynamics Faculty 506, Beijung University of Aeronautics and Astronautics, Beijing, PRC 202-6677 Ext. 5081. He sends his greeting to all of us.—**George Bull,** secretary, 8100 Connecticut Ave., Apt. 919, Bethesda, MD 20815

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The newsletter from the MIT Club of San Diego lists two of our former classmates as members: **George Hatch** and **George Lykos.** . . . **Walter H. (Stocky) Stockmayer** reports another accidental encounter with a '35er. This one was at a performance of *Madame Butterfly* held recently in Lebanon, N.H., "by an increasingly good company called Opera North, involving good young singers from all over the USA and conducted by a Dartmouth professor, Louis Burkot." Sitting in the row directly in front of them were **Henry Kimball** and wife Elinor, who live in Walpole, N.H. (Henry used to live just up the street from me in Swampscott, Mass.) They all agreed to meet again at the 60th Reunion in '95. Stocky says he is definitely slowing down as a hiker, even with only a light pack. In spite of that he plans an ascent of Mt. Carrigain with son Ralph and granddaughter Gretchen, a Yale graduate who has joined the Peace Corps.

A perusal of the latest class list supplied by the Alumni/ae Association has brought to light some interesting information about some of our classmates: **Henry J. Gwiazda** is a probate judge in the New Britain, Conn., Court; **William L. Howell, Jr.,** lives in Jerusalem 91203, Israel; **Wesley H. Loomis, III** is a director of the MIT Club of Southwest Fla.; **Walter Godchaux, Jr.,** is a member of the MIT Educa-

tion Council; **Isa N. Hilu**, a consulting engineer for the U.S. Dept. of Commerce, Mosui, Iraq, lives in Beruit, Lebanon; **Alexandre H. Leal** lives in Rio de Janeiro, Brazil; **Fritz Reber** lives at CH-8463 Benken ZH, Switzerland; **Randolph Antonsen** is not only our class treasurer but one of our five class vice-presidents. The other four are **J. Goffe Benson, Thonet C. Dauphine, Leo H. Dee,** and **Henry B. Kimball** (Henry doubles as assistant treasurer). **Leo M. Beckwith** and **Hal L. Bemis** are our class estate secretaries and Hal is also our class agent of the Alumni/ae Fund. . . . Our Bronz Beaver Award winners are Leo Beckwith, Hal Bemis, and our class president **John F. Taplin.** John is also an honorary member of the Corp Development Committee and ALUM-CORP Visiting Committee HST/Whitaker College Member.

You all know who I am and I respectfully ask that each of you drop me a note or leave a message on my answering machine and tell me how life has been treating you and what you have been doing about it.—**Allan Q. Mowatt,** secretary, 715 N. Broadway #257, Escondido, CA 92025-1880, (619) 432-6446

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Penultimate chapter of the tale of three cities: When I suggested a luncheon gathering of DC-area classmates, **E. "Mac" Nythen** took the ball and ran for a touchdown. He supplemented my list of possible attendees with several at greater distances. Then his calls resulted in a voluble group of seven at the Key Bridge Marriott for a two-hour lunch (and information from several who could not attend—next issue). . . . **Kathleen (Schott) Cummins** (Course VII), after a few years with American Sugar Refining as a bacteriologist, in 1942 "marched off with the first contingent of WAACS, did some military medical research, and then was happily assigned to Army Air Force intelligence." There she married Lt. Col. William K. in 1957 and retired as a major in 1963. At our 1961 reunion she mentioned to **Walt MacAdam** some problems of identifying unknown missiles. He obtained photographs promptly, enhancing her prestige back at her post. After husband Bill's death in 1967, Kathleen took up philatelic specialties, exhibiting internationally, writing and promoting the hobby with children. She knew **Karl Gelpke** and **Larry Kanters** (now both deceased) at Tech, and recalls commuting for free, via father's family pass as a New Haven RR engineer, and walking from Back Bay Station in good weather.

Joe Kingsbury (Course VI), a graduate student from University of Utah, retired in 1976 from AT&T after 40 years in 16 cities. Washington was the last, where he worked on national defense and the White House communications agency. Early on, at NYC Long Lines headquarters he helped organize a barber shop quartet of considerable talent who sang for various business gatherings. In the 1950s he headed a task force to engineer a major conversion of Long Lines routes in preparation for nationwide customer dialing. . . . **Henry McGrath** remembered White Mountain ski trips with Tony Dauphine, '35, on snow trains or in Tony's new car. Henry once bought a used Model T for $155, ducked when it slid under a truck, and was able to bend the top back in shape. He spends some time visiting his daughter's family in New York State.

Paul Robbins came to the Institute from Syracuse University to get an SM in Course I (see page 39 of *Technique*). In World War II he was a civilian troubleshooter for the Army Transportation Corps, first at New York Port of Embarkation, then at all ports east and west. His varied career included night teaching at Cooper Union for 10 years, executive director (now emeritus) of the National Society of Professional Engineers, president of the national Tau Beta Pi and the Council of Engineering Society Executives, and chairman of the visiting committee of Norwich University in Vermont. Norwich and Rose-Hulman Polytech in Indiana honored him with PhDs. . . . It turned out that Paul, Mac, Kathleen, Joe, and Henry all had career contacts with Walt MacAdam, and some with each other, mostly the result of engineering society activities.

Bob Walker gave me bed and breakfast for the two nights before picking up Phoebe at National Airport. We talked about his wife, Thelma (deceased 1990) and the bra-suspension she devised, patented, and he still sells. They hold up half-slips, skirts, and jeans for women who can't tolerate tightness around the waist. Bob's long Commerce Department experience took him all over Europe, including Iron Curtain countries. His favorite was Luxembourg, "60 by 30 miles of beauty, love for Americans, and 'won't you stay with us.'" We toured the now-completed National Cathedral, and happened on **Dave Warner**'s widow, Mary Frances, at the information desk, answering tourists' questions at a fast clip.

Margaret and **Charles Price** were in Santa Fe again in August, she to shepherd another group of opera buffs who saw all five productions in one week. Charlie and I enjoyed Shakespeare's *Romeo and Juliet* on an outdoor stage at St. John's College, with a semi-local cast. The performance surpassed the one Phoebe and I saw at Stratford-on-Avon when we toured Britain in 1976. . . . Readers of *National Geographic Magazine* may have seen **Bernie Vonnegut**'s name on page 92 of the July issue. The article was mainly a photo production on lightning strokes, not a scientific treatise. In 1992 Bernie spoke on "The Atmospheric Electricity Paradigm" at the quadrennial International Conference on Atmospheric Electricity in St. Petersburg, Russia. At the suggestion of peers, he is reworking the text for possible publication in the *Bulletin of American Meteorological Society*.

A note from the family of **Doug Elkins,** Course II, (see page 45 of *Technique*) tells of his death April 3 last year, but no details or their address. When I visited him in Salt Lake City (May/June 1990 Notes), a tumor had blinded one eye, and his health may have been impaired. But he had pleasant memories of his career in the Department of the Interior, and in retirement his engineering expertise had helped the city get rid of smoke pollution. Cheers for his life and that of **Henry Scheel,** renowned boat designer! "Harry" was in Course XIII (naval architecture) but did not return for senior year. Nevertheless, he spent his entire career designing watercraft: for Electric Boat in Mystic, Stonington Boat Works in Maine (Stonington motor-sailers), Morgan Yacht in Florida (including Disney World's side wheeler and submarine), and large ocean-going sailboats for Royal Huisman Shipyard in Holland. More than 2,500 boats by 30 manufacturers have been outfitted with his Scheel keel, which reduces both draft and drag. His Scheel 45 ketch was described by *Time Life Books* as the ideal yacht. A news clip from the Mystic *The Day*, forwarded by XIII coursemate **Ed Rowe,** told the above and of Harry's death July 23, 1993, in Rockport.

Wife Jane (Hall) died in 1990 after 50 years of marriage.—**Frank L. Phillips**, secretary, 1105 Calle Catalina, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson**, assistant secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Here we are in 1994. Did you ever think in 1937 you would be reading about your classmate's activities in 1994? Nice to contemplate, isn't it? . . . **Bob Glancy** catches us up on his busy life in Stroudsburg, Pa. He again participated in the AARP tax-counseling program last spring. It was his first year in Pennsylvania after 10 years in New York. There were a few growing pains, he says. He is also a member of the Golden K. Kiwanis and enjoys helping children with reading and other activities. At the time of his letter, he was planning a cruise to Alaska in July with his daughter, Cavel, to satisfy a lifelong ambition. Hope he writes again about his experience.

Sidney Mank retired in 1976 as owner of the Mank Construction Co. and lives in Washington, Va., where he was visited by **Harry Corman** and wife June (as reported a while back). Aside from the "whale of a garden" he raised during the heat and semi-drought of last summer, Sid and wife Dot are heavily involved with their "convalescent aid loan" organization that loans aids free to folks in their county. Sid does repair work on aids. Sid also works with the Lions organization and keeps pretty busy, which includes trips to Nova Scotia and elsewhere.

Lewis "Pete" Reitz, our 55th Reunion benefactor, still does some electronics consulting but really keeps busy with his record-collecting hobby. Says Pete: "I have recently completed a series of tapes, spanning the years 1926–1945 and containing the hit songs of each year. There are two 90-minute tapes for each year, or a total of 40 tapes." He has also made 45 more tapes covering 1900–1925 and 1946–1980. Quoting Pete: "If any classmates want any or all of these, I'll be glad to make them. I can't legally charge for them, but a donation of $2 per tape will cover the cost of the tape plus shipping charges." He adds that he also has over 500 tapes of the big bands, "if anybody is interested." Pete's address is 700 Mexico Place, Palos Verdes Est., CA 90274.

Holden L'Ecluse of Daytona Beach, Fla., writes that ill health has temporarily kept him and his wife from traveling, though they previously traveled extensively in Britain and Europe and more recently to Mexico. He has two married daughters and three grandchildren. His last occupation was as a motel owner. . . . **Joseph Engel** of Bayonet Point, Fla., is another traveler, visiting his children and grandchildren spread out from Scarsdale, N.Y., to Decatur, Ill., to Dana Point, Calif. At home, though, his major interest is golfing, which is a five- to six-day-a-week "chore."

Fred Kierstead of Brandon, Fla., has retired for the third and last time, he says. He and wife Hermione are strongly involved in church activities, which now fills up all of their time. Fred is a trustee of their church and, for the past two years a member of the Florida State Conference of the United Methodist Church. He takes care of nearly an acre of lawn and shrubbery when not otherwise occupied with his amateur radio station, K4TN. Son Fred Jr. is a professor at the University of Houston Clear Lake. Daughte Suzanne Mathes is chair of the Township Commission of Newton Square, Pa., and her third child, Crista Mathes, graduated from the University of Virginia. Earlier, the Kiersteads lost their older son after a long bout with cancer.

On that note, we sadly report the passing of **Leo B. Moore**, who, until his retirement in 1980, was a professor of management at the Sloan School of Management at Tech. He was also on the board of directors of several companies, including Image Instruments, Cognos Corp., American Sterlizer, and Eaton Co. He received several awards for his teaching and research work and was a fellow of the Standards Engineering Society, which cited him as having done more than any other person to interest young engineers in the problem of standards. A longtime resident of Lexington, Mass., he was deputy director of intelligence for the U.S. Signal Corps in Europe during World War II. Our sympathy is extended to his wife, five children, and ten grandchildren.

Cliff Cochrane, we were sorry to learn, also passed away last January, according to a note from his daughter, Jacquelyn Cochrane Thommen.—**Robert H. Thorson**, secretary, 66 Swan Rd., Winchester, MA 01890; **Leonard A. Seder**, assistant secretary, 1010 Waltham St., Lexington, MA 02173

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Last month's notes said that **Russ Rosano** had a very interesting story to tell about moving to a new home. His former nextdoor neighbor had a tall hedge that blocked Russ's view of Lake Washington and thus detracted from the saleability of the house. Russ approached the neighbor to see if the hedge could be cut back about four feet. The neighbor agreed and said that it would be done the following spring. Came summer and nothing had been done. Russ sent the neighbor a registered letter telling him that a town ordinance could require the trimming of the hedge. Shortly afterwards, a real estate agent arrived with a message from the neighbor that he would purchase Russ's property for cash, and at a very attractive high six figures. Russ and Margo now live in a new condo in a retirement community situated on the top of a 40-acre hill in Redmond, Wash. He says it is quite a change from a 16-room house on one-half acre. Some trimming.

Ed Hadley says that he has a new replacement knee and is coming along very well. I am beginning to wonder if we are becoming a class of spare parts. I now have two hearing aids and two cataract interocular replacement lenses. I am sure that many of the rest of us are in the same boat. Knees, hips, eyes, teeth, etc., all seem to be the order of the day.

An obituary has been received on **Ann I. (Shivek) Mowat V**. This was sent in by the widow of Harry Bloom ('33). Mrs. Bloom writes that Ann died November 11, 1992, on Cape Cod. Ann had numerous positions in chemistry, geophysics, and oceanography. She traveled extensively for the Lamont Geophysics Department of Columbia University doing underwater research. She and her husband, Dr. **John Mowat**, moved to the Cape in 1967 and she became a charter member of the MIT Club of Cape Cod. She was a tireless worker for the club, edited the newsletter, and compiled a history of the club based on interviews with past presidents. Mrs. Bloom would like to know if there is any information on other coeds who attended in 1938.

A note has been received from Hal Seykota,

class of '39 secretary, containing news of the death of **Irvington H. Smith** sent to him by his widow. (She was under the impression that he was '39. He was '38.) He died of Parkinson's disease on June 10, 1993, in Sunnydale, Calif. He worked for 41 years for the Owens Corning Fiber Corp. in Newark, Ohio, and held many definitive patents in asphalt roofing and fine filter media. He had several friends, all of whom have Parkinson's and had worked as chemists or chemical engineers. His widow wonders if there is any data on this.

And last, but by no means least, our next mini-reunion is set for June 3, 1994, at Endicott House following the Institute activities. Several of you mentioned during the 55th that you never got data on our previous reunions. We try to send cards to about 100 possible attendees. Our treasurer won't spring for anymore. If you want to be put on the mailing list but have not received a previous card, send a note to me or to **Don Severance**, 39 Hampshire Rd., Wellesley, MA 02181.—**Horace H. Homer**, secretary, 782 Quaker Rd., N. Falmouth, MA 02556

39 55th Reunion

Fred Grant, chair of our 55th Reunion Committee, reports the members are **Joe Dana**, treasurer; **Jim Barton; George Beesley; L. Burns Magruder, Jr.; Manning C. Morrill; Frederick F. Schaller, Jr.; Sidney Silber; Paul N. Stanton;** and **William F. Wingard.** Before you receive these notes, manning Morrill will have mailed to each classmate a summary from the committee meeting held in September. One hundred sixty-seven classmates answered the questionnaire. Eighty-four either committed to attend the 55th or declared themselves "hopeful." If they all come and bring 70 ladies, 154 persons should make a big sound at sing-along time. Meanwhile, you can help the committee by signing up and sending your deposts early so that orders can be committed for rooms, but tickets, seats with Cardinal and Gray at the Pops, and souvenirs.

Dave Morgan's mention of Professor **Howard K. Schachman**'s prestigious record of achievements led me to phone Howard for facts to publish. Howard wrote modestly in a few lines that he was awarded the Berkeley Citation for Distinguished Achievement and Notable Service, given every year to a small number of Berkeley faculty when they move into emeritus status. Also, Howard was selected by the faculty to be faculty research lecturere next spring. Howard is professor emeritus, and chair of the Department of Molecular and Cell Biology, and research biochemist and director of the Virus Laboratory. His career includes services at the University of California, Berkeley, for 45 years and his *curriculum vitae* impressively covers 36 closely typed lines of unembellished continuous titles of 30 extraordinary honors and awards from U.S. and foreign universities, organizations, and institutions.

Al Chestnut was in the Philippines when Bataan fell. He was a prisoner of the Japanese for three and a half years and made remarkable recovery after World War II. He earned a graduate degree, cum laude, at Harvard Business School and devoted years to Buffalo Forge Co., then a leader in manufacturing equipment that moved huge quantities of air, mostly for public utilities that burned fuels to generate electricity. Al's positive outlook stimulates and inspires.

Brownie Parker spent years with Dewey and Almy, then with W.R. Grace, and later learned forest management in Europe. In 1957 he formed Tree Growers, Inc., in Wayland, Mass., and has managed it ever since. Brownie's fascination with volcanoes and earthquakes led to unusual thrills. While climbing Mt. St. Helens (Wash.) during the week before it blew its top, he felt its rumbling underfoot. Three days before the eruption he was flying around the rumbling crater in a vintage Cessna. . . . **Charler Ryder** retired to Tenafly, N.Y., where his volunteer work includes managing 600 young people in a 44-team league of soccer players.

Paul Stanton and Dora are busy with church and the Reunion Committee and they reserve stories of their adventures until reunion time. . . . **Jim Laubach**, Ruth, and their daughter, Connie, flew cross-country to spend a pleasant evening in Bellevue, Wash., with Nancy and **John Alexander** and **Bob Withington**. Next morning the travelers resumed flight to vacation in Alaska. . . . John Alexander and Nancy joined Hilda and me for a musical presented by Champion Adelines' Chorus and quartets. John and Nancy, conquerors of the Pacific for 22,000 miles in their 43-foot ketch, are about to start a three-week tour of inland China and will share their new adventures at our 55th.

George Morrison and Margery phoned from Seattle, one stop on their 5,000-mile trip that started in Peterborough, N.H., and will include Mt. Rainier and Mt. St. Helens in Washington and the Columbia Gorge, Bonneville Dam's powerhouse, fish ladder, and hatchery, and Crater Lake in Oregon. Hear details directly from them at the 55th. . . . **Morrie Nicholson** and Norma celebrated their 50th wedding anniversary on August 21, 1993. . . . **Bob Laird**, retired after a country-wide career in textiles, reports he enjoys good health and the good life in Hagerstown, Md.

Hilda and I went to school for four hours on each of two days and paid $8 to improve our minds. The course was a refresher on a safe driving (auto, not golf). We mailed the diplomas to our auto insurer, who is to reduce our insurance premiums. Apply to AARP if you are interested. . . . **Bill Murphy** and Anne vacationed in New England, maintain their golf handicaps in Clearwater, Fla., and plan to attend the 55th. . . . **Harry Shubart** writes from Evanston, Ill.: "During summers we play tennis and windsurf on Lake Michigan. In winters we travel. We plan to see Yemen and Jordan next, and then visit our children in Berlin and London."

Art Zeldin and Helen made a deluxe comprehensive tour of Scandanavian countries, all pleasant except for a fall that bruised Art's right forearm. Art and Helen have many adventures abroad and will bring the stories to the 55th. . . . Just now **Bob Sackheim**'s letter arrived. He writes: "I most sadly report my wife, Betsy, died August 14, 1993. She had been ill for three years and put up a good fight until the end. We had been married for just over 50 years. I am sure reunion goers will remember Betsy as the one who wore the 1939 numerals on her sweater for the group picture."—**Hal Seykota**, secretary, 2853 Claremont Dr., Tacoma, WA 98407

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I have a letter from our class agent, **Walt Helmreich**, in which he reports on our class giving for fiscal year '93. I shall quote it in full in the next issue. Please send any information

you have to **Richard E. Gladstone**, secretary, 250 Hammond Pd. Pkwy., Apt. 1205S ,Chestnut Hill, MA 02167

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Please send news for this column to: **Charles H. King, Jr.**, secretary, 7509 Sebago Rd., Bethesda, MD 20817, (301) 229-4459

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Chuck Lawrence, Course VII, writes that his firm, Lawrence, Fisk & McFarland just completed its first 10 years of civil and environmental engineering practice. **Dick Stout**'s Bear State Pump and Equipment Corp. of Ontario, Calif., collaborates with Chuck on pumping installations.

Two obits: **Harris Hanscom**, Course II, in Barrington, R.I., and **Ron Shanin**, Course XVI, in Huntsville, Tex. Ron was well known as an explorer and as a producer of documentary films, and he shared some of his films with us at several class reunions.—**Ken Rosett**, secretary, 2222 Americus Blvd., N, Clearwater, FL 34623

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News has come that **Kenneth R. Gifford** passed away June 22 in Farmingdale, Maine. After graduation from MIT Kenneth served in the Army in World War II, reaching the rank of captain. For 30 years he was the principal owner and president of Wadleigh's Inc. of Hallowell, Maine, retiring in 1984. He was active as an officer of his Congregational church, as trustee and treasurer of Wilton Academy, in local political and educational affairs, and as a legislator in the Maine House of Representatives. He served as a local and district leader in the Boy Scouts, president of the local and state fuel oil dealers associations, and VP of the New England Fuel Institute. Kenneth is survived by his wife, Betty, eight children and stepchildren, as well as numerous other relatives. We extend our condolences to them.

We are indebted to Betty McLaughlin for further information on her late husband, **Edward H. McLaughlin, Jr.**, whose brief obituary appeared in the July Class Notes. Ed served as an Air Force captain in the Pacific Theater during World War II. After leaving the service he rejoined an earlier employer, Union Hardware and Metal Co., which eventually became McLaughlin Industrial Distributors. He was president of the company from 1968 until his retirement in 1989. He was also an avid skier and golfer, being a member and officer of several related associations in southern California. He enjoyed the esteem of his family and many friends.

Leo Fitzpatrick, Jim Hoey, Kemp Maples and **Hans Walz** sent me clippings of a recent article in the *Boston Globe* Business Section about **George Freedman** and his company, Invent Resources. It's a terrific story, which I'll save for the next issue to avoid conflict with "Reunion—The Final Report."

After breakfast Thursday the Reunion returned to Cambridge for the Technology Day weekend. We started with a reception in the courtyard of President Vests' home, proceeded to cocktails and dinner at Walker, then had VIP seats for Tech Night at the Pops, and signed off with the Post-Pops Benediction at the Y'all Come Back Saloon (McCormick Hall).

Friday began with a memorial service in the Chapel, where we honored our 163 departed classmates. Between the intellectually stimulating Tech Day program sessions in Kresge we attended the lunch and Class Gift ceremonies. To the amazement and satisfaction of all, **Stan Proctor** had surpassed his goal of $4 million by $5x10^{-6}$ percent. Later, the photographer managed to round up the group for an impressive class picture, taken with a 1943 vintage panoramic camera, reportedly the last of its kind. Another McCormick reception prepared us for an awesome visual experience in the Boston Science Museum's Omni Theater, then dinner in the aptly named Skyline Room, with Provost Mark Wrighton as our speaker.

Saturday morning we could view the Sea Grant and Ocean Engineering displays in the Building 7 lobby, or attend an entrepreneurial forum for any never-say-die classmates wanting to start a new business. The closing scene was played out at the mammoth barbecue next to the Johnson Athletic Center, after which we were content to say our goodbyes and make our separate ways back to the real world.

With 241 attendees at the various Reunion events, it wasn't possible to interview each classmate. I did, however, pick up several items of miscellaneous personal news.

Adele and **Bob Caldwell** brought with them a young protege who loves math and science and hopes to pursue them at MIT. . . . Betty and **Bud Cruckshank** celebrated their 50th wedding anniversary June 19 by taking a Caribbean cruise. . . . **Dick Feingold**'s guest, Betty Roberton, associated with Nabisco, kept the Reunion supplied with peanuts. . . . **Bill Foulks** had a soapbox from which he declaimed alternately on the sorry state of national politics and the massive virtues of the National Rifle Association. . . . **Ray Frankel**'s wife, Maxine, is an accomplished sculptress, with a busy studio in their home on a Los Angeles hillside. . . . Former MIT saber fencer **Jim Harker** and his guest came to the Reunion all the way from Aldington, Kent, U.K. . . . Bunny Knauer and son Warren Jr. were present, renewing our memories of Warren Sr., while Jackie Ward did the same for John. . . . **Iz Lenzner** recalled a long-ago complaint of his father, head of the family food business: "I sent you to MIT for four years and you haven't invented a new flavor yet!"

If anyone wants a list of 50th Reunion attendees, I can get copies from the Alumni/ae Association. Just send me a request with a stamped return envelope.—**Bob Rorschach**, secretary, 2544 S. Norfolk, Tulsa, OK 74114

44 50th Reunion

The material for the 50th Class Reunion Book is being worked on for submission to the printer. We hope everyone has filled out and returned his/her biography sheet. In case you have forgotten to do it, there still may be time to squeeze it into the book. Registration material for the reunion is in process and will be mailed out in a month or so.

We regret to report the passing of **Arthur J. Slemmons** on February 19, 1993, in San Jose, Calif. He is survived by his wife, Margaret, of Los Gatos, and two sons, a daughter, two sisters, and three grandchildren.

Art was born in Oconomowoc, Wis. During

a career that spanned four decades with giants of industry and research, he put his name on 17 U.S. patents. He was also a man of the arts, receiving a bassoon scholarship to Carleton College in Minn. After receiving his MIT degree, he worked for Chrysler in gas turbine development and played bassoon in the University of Michigan Extension Orchestra, where he met his wife, Margaret, a violist. At FMC Corp. he worked on a tea harvester and a mulching mower. He also became involved in solar energy, which led him to Stanford Research Institute International, where he designed power-plant-size solar designs.

Over the years, Art and Margaret played in local orchestras. In addition to the bassoon, Art played the cello, the piano, and the Italian concertina. His sons and daughter also played instruments. The family quintet played chamber music during holidays and for special occasions. He enjoyed sailing his 32-foot sloop around San Francisco Bay. A heart condition forced his retirement from SRI in 1984, but his bone cancer had not been diagnosed until three weeks before his death. We extend the class's sympathy to all his loved ones.—Co-secretaries: **Andrew F. Corry**, P.O. Box 310, W. Hyannisport, MA 02672; **Louis R. Demarkles**, 77 Circuit Ave., Hyannis, MA 02601

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In 17 months we will be celebrating our 50th Reunion. Hard to believe but true. Your Reunion Committee held its first meeting in the Bush Room 10-105 on Thursday, September 16. By the time you receive these notes, we will have decided where our off-campus activities will be held—hopefully the dry mainland and not the rainy Cape.

The Institute's academic year has been extended by one week and all future graduations will be on a Friday. Accordingly, our 50th Reunion will occur between June 9 and June 16, 1995. Airline regulations, being what they are, may allow you to make a reservation now and be paid by the airline for doing same! Whatever, please mark your calendar and plan to attend.

Again, I want to thank all of you—including members of '43, '44, '46, '47, and '48 for the V-12 information and support you supplied during the past year or so. As previously reported, there will be no V-12 Reunion; however, you will find many V-12ers wandering around campus should you attend Technology Day in 1994, 1995, or 1996. We hope that Technology Day 1995 will be billed as a 50th celebration of the Institute's World War II activity.

Ms. Robin Buik has advised that her father, **Charles (Chuck) Buik, III** of Hinseburg, Vt., passed away March 23, 1990. We all remember Chuck as our V-12 bugle boy—particularly by the 0600 calisthenics call! . . . Another V-12er, Dr. **Howard A. Mermelstein**, a practicing pediatrician in Pittsburgh, Pa., died May 15, 1991. . . . **Dave Cohen** of Roslyn Heights, N.Y., continues to be active in car leasing, export trade, and computer leasing.

Alvin Cohen of Boynton Beach, Fla., wrote the following last spring: "After graduation, it was Columbia Midshipman's School, duty at Charlestown, S.C., Naval Base; Port Wyneemie, Calif.; Port Director's School; San Francisco as a port director; and finally discharged back to civilian life. Graduate work at Lowell Textile Institute and then joined a family business. Struck out on my own with a sweater manufacturing plant in 1963, sold out to a multi-product men's sportswear company (Campus Sweater and Sportswear Co.) with headquarters in New York City, and we moved to New Rochelle, N.Y., where we lived for 28 years. There I raced my Rhodes-19 sailboat on Long Island Sound. I was the executive VP in charge of all manufacturing, both domestic and imports; we had 21 wholly owned domestic plants, 75 domestic contractors, and imported from 19 countries. I traveled all over the world many times for many years. Campus sold out to Interco, Inc., a multi-billion-dollar conglomerate, in 1978.

"Along the way, Debby and I married in 1947 and raised two wonderful children. Our son, Mark, graduated MIT, '74, with two degrees, and then went to Columbia Medical School. A pediatrician neonatologist, he is married to an internist specializing in infectious diseases. They have a son and daughter and live in Acton, Mass. Our daughter, Nancy, with a master's in Social Work, works for the Fairfax County Virginia School System and is married to a VP of a specialized information company. They have two boys and live in Annandale, Va.

"In 1990 I retired and we moved to Florida to enjoy the sunshine and the good life. Every day is Sunday down here. We spend our time playing golf, swimming, taking courses at Florida Atlantic University, reading, and traveling. I am still doing consulting work for clients who value my expertise on manufacturing in the Caribbean and Central America. Debby and I have rented a house on Otis Lake in the Massachusetts Berkshires for August and September, as it gets quite humid in Florida that time of year. We'd love to get a call from anyone in that area during those months at (413) 269-7474, or here in Florida at (407) 369-4368."

Pete Hickey, Fran, and I had a most pleasant visit with Libby and **Jerry Paterson** of Midlothian, Tex., down on the Cape in mid-September. Jerry and Lib were celebrating the 49th anniversary of their initial introduction, arranged—would you believe—by Lou and Peter Hickey.

A belated Merry Christmas and Happy New Year to you all.—**Clinton H. Springer**, secretary, P.O. Box 288, New Castle, NH 03854

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Hope you all have a Happy Yuletide. Please send news.—**Jim Ray**, secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Please send news for this column to: **R.E. (Bob) McBride**, secretary, 1511 E. Northcrest Dr., Highlands Ranch, CO 80126

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Dave Freedman and his wife, Beverly, have added another service bar to their eight prior trips for the Internation Executive Service Corps. They went to Kingston, St. Vincent, where Dave worked with 11 bakeries to demonstrate new baking techniques and provide new recipes. Most of his recommendations were implemented almost immediately. Following the visits he conducted a seminar for all the bakeries in which he provided advice on the improvement of sales, both retail and wholesale; developed sanitation and preventive maintenance schedules; and explained inventory control and purchasing procedures.

Dave will contact bakery supply companies in the United States that are able to supply products at lower prices than the current suppliers in Europe. One bakery in St. Vincent will act as distributor.

Tom Lacy continues his sheep farm activities in Fitzwilliam, N.H.

Those of you with gigabyte memories may remember that from 1968 to 1977, several columns of the class notes were written from a cabin about 50 feet from the Atlantic Ocean in Birch Harbor, Maine. These notes are being written on my Macintosh computer about 120 feet from the Atlantic Ocean in Corea, Maine. A six-foot-by-six-foot window allows me to watch the breaking surf as I write these notes (using touch typing).

The cabin is on a peninsula with about 7,200 feet of ocean frontage. My dog, Elsa, and I traverse the shoreline and paths that cross the peninsula every day. The *Wall Street Journal* is at the post office at 8 a.m. for the current day. This year I obtained a cellular phone to eliminate the 12-mile (round-trip) drive to a telephone pay station. I rent the cabin for four weeks and build a fire for warmth since the temperatures have been 50° to 60°. A friend who lobsters provides fresh large lobsters at $2.25 per pound. Frankly, I cannot think of anything more I could need.—**Marty Billett**, 16 Greenwood Avenue, Barrington, R.I. 02806, (401) 245-8963.

49 45th Reunion

According to the July 1993 issue of *128 News*, a publication aimed at the technical folks around Route 128 in Boston, **Eric Howlett** is about to market a product called Cyberface 3 that enables users to inspect a product inside out before it's even been built. I read the whole article but couldn't understand what Cyberface 3 was all about, so I called Eric at his Waltham, Mass., company and soon learned all I will ever need to know about his mind-boggling invention. What happens is this: A lightweight frame is attached to your head. The frame contains sensors that tell a computer how your head is oriented. If you look down, the computer knows it and by exactly how much. If you turn to the right, the computer knows that too. As the news release states: "The head-mounted display and tracking system acts as a doorway into virtual worlds." You also have lenses in front of your eyes. Now Eric turns the machine on. Immediately you see whatever has been stored in the computer. Let's say you are evaluating a building for which not a shovel full of earth has yet been turned. Computer-aided-design files in the computer enable you to look at the building just as if you were walking around in it. Oops, here on the 19th floor is a door you shouldn't walk through because it opens to the empty air. A software error, maybe? You make a note to fix it. Want to drive through the third Harbor Tunnel in Boston before it's built? Just plug the appropriate CAD files into the computer and step on the gas. Says Eric: "We expect to make 100 to 200 Cyberface 3 units over the next couple of years."

John R.M. Alger writes: "We are happily ensconsed in Rumney, N.H., where we are rural and urban activists. My wife organized a Perot group here and I'm trying to get engi-

neers legislation through our State legislature while *hoping* we 'olders' don't get a big tax but reduce spending instead." Over the phone John told me that the environmentalists and animal lovers are getting the upper hand in town. He had a black bear on the porch recently, elk abound to the peril of motorists, and wolves, he understands, are on the way.

The management and staff of the Class of 1948 invited members of the Class of 1949 to attend a banquet with them in the Empress Room of the Hyatt Regency Hotel on Memorial Drive in Cambridge this past June. The room commands a fine view of the Charles River and Boston. Among classmates and their wives who enjoyed the occasion were **Raffaele Belluardo, Jim Christopher, Bob Cowan, Fletcher Eaton, Don Gillespie, Harry Lambe, Ray Larson, Micky Ligor, Don Ridgley**, and **Tom Toohy**. All of us appreciate the warm hospitality always extended to us by the fine Class of 1948.

Another recipient of aid from the Class of 1949 Scholarship Fund has written to express her thanks. She is Marion Casserberg from Knife River, Minn. Like all of the rest of the students we help, Marion is heavily involved in extra-curricular activities—in her case basketball, volleyball, the Undergraduate Research Opportunity Program (UROP), and desk captain of Bexley Hall.

At a meeting of the Reunion Committee held at the Institute on August 31, **Stan Margolin** reported on the Bermuda reunion survey to which many of you have responded. A majority voted for a reception on Saturday night, a boat cruise and dinner on Sunday night, a sailing cruise on Monday, dinner at a Bermuda home on Monday night, and the class dinner on Tuesday night. By now, further information should be in your hands but, for the record, the hotel for the Cambridge part of the Reunion will be the Cambridge Marriott. I may be biased, but I think it safe to say that no class at the Institute has a more skilled and experienced Reunion Committee than ours.

In the October notes I wrote: "According to a note from his wife, Joan, **Richard A. Cotton**, 65, died on December 4, 1992. He was retired and living in Franconia, N.H." Prompted by that regrettably brief notice, **Gene Wroblewski** has filled in one facet of Dick's life in a letter dated July 29, 1993.

Gene writes: "I noted with sadness that Dick Cotton passed away recently and this started a chain of thought about a conversation we had during our 25th Class Reunion, almost 20 years ago. We were having tea or cocktails at the campus home of Dr. Jerome Wiesner, then MIT's president. When I asked Dick how he was getting along in life (a standard 25th Reunion question to someone I hadn't seen in 25 years), he replied that he had retired recently.

"Since it was very unusual for one of us to retire before reaching 50, I probed a little further, hoping for a revelation that I could use. His answer was simple enough: 'I hit it big in the stock market and decided to get out of the rat race.'

"I asked him what he did with all the time on his hands, and he replied, 'I have three homes in different parts of the country. I'll stay in one place for a few weeks and when I grow tired of that spot, I'll move to the second place. After a few more weeks, or whenever the spirit moves me, I'll move to the third house.' Continuing, he mused a bit further. He said, 'You know, about a month ago I got a consulting job at which I work one day a week.' He paused in thought, then said, 'It's amazing how I look forward to that one day a week.'"

In an all-too-brief letter, Marion F. Byram, wife of **Robert E. Byram**, states that her husband died June 27, 1993, at the age of 77. I deeply regret the absence of any further detail.—**Fletcher Eaton**, secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

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Please send news for this column to: **John T. McKenna**, secretary, P.O. Box 146, Cummaquid, MA 02637

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Following his retirement in 1990 from UTC as director of engineering, International Fuel Cells, **John M. Lee** has been cruising the Caribbean from Florida to Venezuela in a 43-foot ketch. He has been doing some consulting on commercial applications of fuel cells.

A new staff position at Amdahl Corp. for software business development will be headed by **William O'Connell**. He will be striving to make software a much larger contributor to its revenues and earnings. Coming to Amdahl in 1977 as senior VP for corporate marketing, he later assumed responsibility for international operations developing new markets in Canada, Europe, and the Far East. He most recently served as senior VP for corporate strategy. Prior to coming to Amdahl, he was with IBM for 23 years in senior sales and planning management positions.—**Martin N. Greenfield**, secretary, 25 Darrell Dr., Randolph, MA 02368

William O'Connell

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Herbert H. Dow was elected a life member of the MIT Corporation last May. He recently retired from a long career at Dow Chemical.

Another retiring classmate: **Frank Gauntt** retired last spring after 37 years at Charles Stark Draper Laboratory.

William T. Rusch, who retired in 1991 from a 35-year career at Sanders Associates, now Lockheed/Sanders, died July 16, 1993. He also served in the U.S. Army during the Korean war. He is survived by his wife, Judith, three sons, and three daughters.—**Richard F. Lacey**, secretary, 2340 Cowper Street, Palo Alto, CA 94301; e-mail: lacey@hpl.hp.com

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Let me continue to provide information on classmates who attended our 40th Reunion. . . . Notably present were Christiane and **Jack Walsh**; as usual Jack was nattily attired and enjoyed the festivities. In January 1990 he retired (as senior VP) from York International Corp.; he now has a small consulting office in York, but they spend 20 weeks a year on their farm in France and another two weeks on St. Bart's. Jack's primary interests are horses and fox hunting.

Another pair of Californians, Ann and **Joe Myers**, were part of early breakfast "reunioners" at the Cape. After 30-plus years with IBM (ranging from systems engineer in Baltimore to senior programmer in Palo Alto's Scientific Center, where his last project was a radiology display station now being used at the Mayo Clinic), Joe retired in 1991 but has since been consulting and programming in the area of medical image displays. All five of their children are on their own, while Joe and Ann obviously are enjoying life in Los Altos.

Also present at MIT and Cape activities were Ruth and **Jack Shulman**. Following a 20-year career with a small hi-tech company and rising to president, Jack accepted a chair at the University of Minnesota, where he directs the Center for the Development of Technological Leadership and chairs the Industrial Engineering and Operations Research Division. Lest he be regarded as a slacker, let me add that he also launched a new interdisciplinary graduate program in the management of technology. (Does anybody, including Jack, know that he is one of only four of our 600 classmates who holds four MIT degrees?)

Fred Brecher, accompanied by Jeanette Sparks and, as always, his camera, attended the entire reunion. In his words: "Jeanette and I are happily ensconced in our new home. My new business is now two years old and it looks like we may make a success out of it despite the rotten construction climate. No grandchildren yet, but I don't feel old enough to be a grandparent."

Sheri and **Edward Leonard** were present at the MIT functions. He has been a longtime professor of chemical engineering at Columbia University and has specialized in "applying chemical engineering to the design of artificial organs (kidneys, hearts, blood vessels, etc.). Five to eight kids (depending on how you count, I'd say eight). Very busy teaching, researching, consulting, fathering, grandfathering, husbanding." . . . Also celebrating our 40th were Peg and **Leonard Ehrman**. In 1988, he retired (as VP technology) after 26 years at Signatron. They then moved to East Sandwich, Mass. Even better, the two spend the summers on their 40-foot sloop, with July and August primarily in Maine. Their only child is married, lives in Alexandria, Va., and just finished a PhD at George Washington University.

Of course, the ever-pleasant Peggy and **Ben Coe** were among us (and were heroes on the outer bar at Chatham, as reported earlier). They live in (brrr!) Watertown, N.Y., and have two grandchildren. Ben continues to serve as executive director of N.Y. State's Tug Hill Commission, plus a one-year stint as president of Jefferson County United Way.

Yet another California pair, Joan and **Ed Butler**, joined the happy throng. After 38 years as a Delta Airline pilot, Ed retired in 1990. Also, this clever twosome contrived to reduce future legal hassles and padded bills, to wit: their daughter has five years as a working attorney. . . . Peggy and **Robert Bonazoli** were on hand for the MIT activities. After 36 years of service with Sylvania Lighting, Robert retired when GTE sold the business to OSRAM. For the last eight years he was director of engineering for the U.S. division.

Dorothy and **Jim Ricketts** sallied forth from California and stayed for the full reunion. (Lest you wonder, Jim was the friendly heckler when yours truly presented the class survey data.) Jim has retired from both GM and Ford and is now writing programs for small businesses. Interestingly, he adds: "Our plans are

to become gypsies when our house sells—traveling the country in our RV, then settling on the Olympic peninsula in Washington."

More news on reunion attendees is still to come. Even so, do not forget to keep me and thus the class informed of your whereabouts and activities.—**Martin Wohl**, secretary, 4800 Randolph Dr., Annandale, VA 22003, (703) 354-1747

54 40th Reunion

Our 40th Reunion is only six months away. We hope that you have marked the dates (June 1 through June 6, 1994) and plan to attend. **Bob Anslow** has long since signed up. He describes himself as "semi-retired and consulting," but wouldn't miss the class festivities. As the days go by, you will be getting more information from **Bob Warshawer** as plans fall into place.

John McGann is also making plans to attend the reunion. He is "still working," he says, with about one and a half jobs as a consultant in the computer industry. He also finds time to run and teach. John lives in Upper Montclair, N.J. . . . We have learned that **Herb Lee** has died, but have no details.—**Edwin G. Eigel, Jr.**, secretary, 33 Pepperbush Lane, Fairfield, CT 06430

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Samuel "Sandy" Goldman (Course VI-A), currently president of Techniscribe, Inc., of Canton, Mass., was invited to present three seminars on technical writing in Asia this past October. Titled "Effective Technical Writing," the seminars were presented in Singapore; Kuala Lumpur, Malaysia; and Jakarta, Indonesia, under the auspices of the Asia Pacific Institute for Management Development. Sandy's firm specializes in the development and production of technical manuals, seminars, and courses for areas including operator, service, and installation manuals and product demonstration. Sandy has also led seminars in "Efficient Leadership of Engineers and Scientists" and other marketing and management topics for industrial corporation. Following graduation from MIT, Sandy received a degree from Columbia University, taught at both institutions, and was a Fulbright Fellow in the Netherlands. He has consulted and written extensively in fields such as management of engineering operations, laboratory and clinical medicine, controls and instrumentation, biochemistry and pharmacology, oceanography, and applications software.

For paucity of other classmates' news, your co-secretary, **Roy Salzman**, will report that he was pleased to share a "60-90 Birthday Bash" on September 25 with his Dad, Milton G. Salzman, '25. Roy was born on his father's 30th birthday and by coincidence (and sometimes to his chagrin) did almost everything his father did 30 years later, including entering and graduating from MIT, going into the armed services (his father into the Army Corps of Engineers, Roy into the Air Force Strategic Air Command), spending a career in consulting (his father in civil/hydraulic engineering, Roy in computer systems and manufacturing automation), both traveling a great deal, etc. Roy says that if he can be as active, agile, and alert as his father was on his 90th birthday, he'll be happy to have followed so closely in his footsteps.

Spare yourselves this trivia! Send notes! Co-secretaries: **Roy M. Salzman**, 4715 Franklin St., Bethesda, MD 20814; **James H. Eacker**, 3619 Folly Quarter Rd., Ellicott City, MD 21042

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Russel L. "Rusty" Schweickart was recently introduced into the Aviation Hall of Fame of New Jersey. Some 450 guests attended the 21st annual dinner, a fund-raiser to help maintain the museum, which was founded in1972, and is dedicated to preserving New Jersey's 200 years of aviation and space heritage. As a 33-year-old rookie astronaut on the March 3, 1969, *Apollo 9* mission, Schweickart walked in space for 38 minutes as part of the lunar module test team. He and fellow astronauts Jim Mcdivitt and Dave Scott nicknamed the module *Spider*, and their command ship, *Gumdrop*.

Schweichart served as the backup commander for the first Skylab mission and later joined the NASA headquarters in Washington, DC as director of user affairs in the Office of Applications. He was California's Commissioner of Energy as well as chairman of the U.S. Antarctic Program Safety Review Panel for the National Science Foundation. He is currently president of Courier Satellite Services, a San Francisco-based commercial communications company. Also, he is a founder of the Association of Space Explorers, an international society of astronauts and cosmonauts.

Ted Korelitz is chairman for our 40th Reunion. In June he held a planning meeting with the following attendees: Ruth and **Lloyd Beckett, Margie Gilson**, Bridgit and **Klaus Kubierschky**, Dianne and **Ted Korelitz**, Lori and **Ron Massa**. Items discussed included the reunion date, June or September, and whether it would be held on or off campus. There was a preference for June with plans to include on-campus activities Thursday and Friday and off campus for the rest of the weekend. Ted would be happy to hear your suggestions at 136 Beethoven Ave., Waban, MA 02168-1728.

Please send news to **Ralph A. Kohl**, co-secretary, 54 Bound Brook Rd., Newton, MA 02161

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Please send news for this column to: **John Christian**, secretary, 23 Fredana Rd., Waban, MA 02168

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Please send news for this column to: **Mike Brose**, secretary, 75 Swarthmore St., Hamden, CT 06517

59 35th Reunion

The mail this month includes a copy of the *Princeton Weekly Bulletin*, featuring a front-page article announcing that **Frank von Hippel** was honored as a MacArthur Fellow for 1993. Frank is a professor of public and international affairs at the Woodrow Wilson School, and specializes in both policy and technical aspects

of nuclear weapons. He recently worked to lay the groundwork for disarmament and plutonium disposal in conjunction with scientists from the former Soviet Union. After MIT, Frank earned his DPhil in physics from Oxford University and served at a number of Nuclear Laboratories before going to Princeton in 1974. The award includes substantial stipends over a five year period, with complete freedom of use. Congratulations, Frank.

Frank von Hippel

Dix Browder and **Larry Boyd** with spouses Sara and Bette were together for a golf outing in central Oregon this summer. They sported impressive hats and looked quite professional, although a scorecard was not included in the communication.

Reunion planning continues at a healthy pace, as does the class gift effort, under the able directions of **Jack Fischer** and **Art Colias**, respectively.

A brief update on my own activities: Ginny and I still live in Bedford, Mass.; same historic house but with a modern addition (where we spend most of our time). Only one of our five children is still at home, with the other four appearing to be successfully launched or close to it. After a long career with Digital Equipment, in both Massachusetts and Geneva, Switzerland, I "retired" last year to search out new opportunities. Currently, I am working at a small Cambridge consulting firm (Gould-Kreutzer Associates) as both CFO and consultant. This firm is closely allied with MIT people and brings to industry the power of systems dynamics in dealing with major issues and strategies. This is like coming full circle, for it was in this area that I worked in its early days at the Sloan School as part of an exciting new group headed by Professor Jay Forrester and which I always believed had enormous potential for the transformation of business activity. Now that industry broadly recognizes the need for dramatic change in many quarters, the opportunity for helping companies understand and use the philosophy, concepts, and tools (ranging from brainstorming to identify the causal loop structure underlying issues to computer simulation and even "management flight simulators") provides for some very exciting work! In addition, Ginny and I have recently developed a "job sharing" relationship in the management activities of the firm, as she brings a wealth of experience from her consulting, marketing, and small business background. We are both working harder than we really want but having fun doing it!

I urge you to *actually do it*—send an update that will be much appreciated by your classmates, and to stimulate other classmates to do the same!—**Dave Packer**, president, 31 The Great Road, Bedford, MA 01730, (617)-275-405

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As I write this, the Rose Garden handshake between Messrs. Rabin and Arafat gives one more indication that we may have reason to hope for a brighter future. Thus, in the hope for peace, your secretary sends his very best wishes to you all for a healthy, happy, and peaceful 1994.

While on the subject of peace, the United States Institute for Peace announced the selection of **Richard Solomon** as its president. Dick previously served as U.S. ambassador to the Philippines, and as an assistant secretary of state for East Asian and Pacific affairs. The institute is an independent, nonpartisan organization created by Congress to promote research, analysis, education, and training on international peace.

Princeton University has announced the appointment of **Howard Rosenthal** as William Straus Professor of Social Sciences in the Department of Politics. Howard was previously at Carnegie-Mellon University and joined Princeton following two years as fellow at the International Center for Research in Turin, Italy.

Please keep the news coming. . . . Happy Holidays!—**Frank A. Tapparo**, secretary and class agent, 15 S. Montague St., Arlington, VA 22204

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Please send news for this column to: **Andrew Braun**, secretary, 464 Heath St., Chestnut Hill, MA 02167 or via Internet: andrewb820@aol.com.

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Vijay Shah turned up in a color photograph on the front page of the *Boston Globe* on August 8, 1993. The article accompanying the picture was on membership at country clubs in the Boston metropolitan area. We were hoping that the article would have some words of wisdom from Vijay on the subject of the article, but search as we might, I couldn't find a quote from our classmate. However, the caption indicated that Vijay is a member of Newton's Brae Burn Country Club, but I couldn't tell from the photograph if he was wearing a kilt.

Bill Koch was back in the news on the front page of the business section of the Friday, September 24, 1993, issue of the *New York Times*. It seems that Bill is looking at MGM as a possible investment for his Oxbow Corp. He has apparently retained International Creative Management "to solicit information about MGM on behalf of Oxbow Corp. so that Oxbow can evaluate the feasibility of the purchase of all or part of MGM." If Bill handles this as well as he handled the America's Cup, I suspect our classmate will be a major player in the entertainment industry in the not-too-distant future. The article indicated that a spokesperson for the giant French bank, Credit Lyonnais, had some rather snide comments about Bill's method of approaching the possible acquisition. If I'm any judge, that challenge will just fuel the probability that MGM might make an interesting match with Bill's Kendall Square Research Corp. of Waltham, Mass., which produces supercomputers.

Alan Kotok sent me an e-mail message that arrived too late for the last Class Notes column. He now has new responsibilities at Digital Equipment Corp. as technical director of the Corporate Strategy and Alliance Group. This promotion has brought Alan back to Maynard Mill, close to the first office he had at Digital 31 years ago.

Theodore J. Sheskin wanted to update a comment he made in a recent Class Notes column. He dropped us a short note indicating

WINEMAKER DAVID STARE, '62

If Life Gives You a Lemon, Bottle It

The wines of Dry Creek Vineyards have garnered over 1,000 awards at state fairs and international competitions for winemaster David Stare, '62, with the Loire-style fumé blanc that Stare introduced to northern California leading the list. But his most recent innovation is more unusual. In an effort to find some use for a batch of inferior grapes, the vineyard came up with a solution that addressed a serious industry problem—and did it with a dash of pungent humor.

Stare remembers his parents warning him as a child, "Be careful what you wish for—you might get it!" But now his vineyard is more than 21 years old, and he has no regrets. Stare traces his dream of becoming a winemaker to the year when he was social chairman of his MIT fraternity, Delta Upsilon. The store where he purchased libations—and frequently discussed wines with the owners—gave him a case of selected wines in appreciation for his business. This became his first winetasting test, shared with his fraternity brothers.

He still remembers their favorite: Lancer's crackling rosé.

After MIT, Stare earned an MBA at Northwestern but lost none of his fascination with winemaking. When he was working as an industrial engineer for the Baltimore & Ohio Railroad, he took the first step, planting 40 vines near the family garage. Then a work assignment in Koblenz, Germany, enabled him to spend vacations delighting in the wines of France's Loire Valley. Back in the States, he and his family moved to California so he could attend winemaking classes at the University of California, Davis. By 1972, he was ready to take the plunge, establishing the first new winery in the Dry Creek Valley of Sonoma County since the days of Prohibition. He subsequently introduced the region's first fumé blanc, the wine that had captivated him in France.

Dry Creek Vineyards has prospered, and in recent years it doubled production to supply newly developed markets on cruise ships and in Europe. But lately, the northern California vineyards have suffered from an infestation of *phylloxera*, a parasite that nearly destroyed European vineyards a century ago. This louse invades the vine roots and causes a gradual decline in the flavor of the grapes.

The problem hit home when Dry Creek received a contract lot of cabernet sauvignon grapes that lacked the sugar content—usually more than 23½ percent—needed to produce the intensity and complexity of a full-bodied cabernet wine. When the grapes only mustered 20 percent, Stare instructed the winemaster to blend a rosé, which is less demanding. Dry Creek doesn't usually sell a rosé, so marketing this batch of wine became a challenge.

"What are we going to do about *that* wine?" Stare kept saying, reports his daughter, Kim Stare Wallace. Kim is the winery's vice-president and director of marketing, and she had a suggestion. Why not sell it under a "Bug Creek Vineyard" label, design

1991
Rosé of Cabernet Sauvignon
SONOMA COUNTY
Alcohol 12.5% by volume

the label to educate winelovers about the infestation of northern Californian vineyards, and contribute ten percent of the proceeds to *phylloxera* research?

Undaunted by naysayers, Dry Creek did just that. It was the first winery to bring public attention to the what Stare calls "this pesky bug," and the project was a huge success. In 1991, they produced 900 cases of Bug Creek Vineyard rosé. Its novelty made the wine a collector's item, and it sold out rapidly. A smaller batch from 1992 grapes still sells in the tasting room of the winery. The Stares recently wrote a check for $5,000 to the American Vineyard Foundation, which oversees the search for a long-term solution to the infestation.

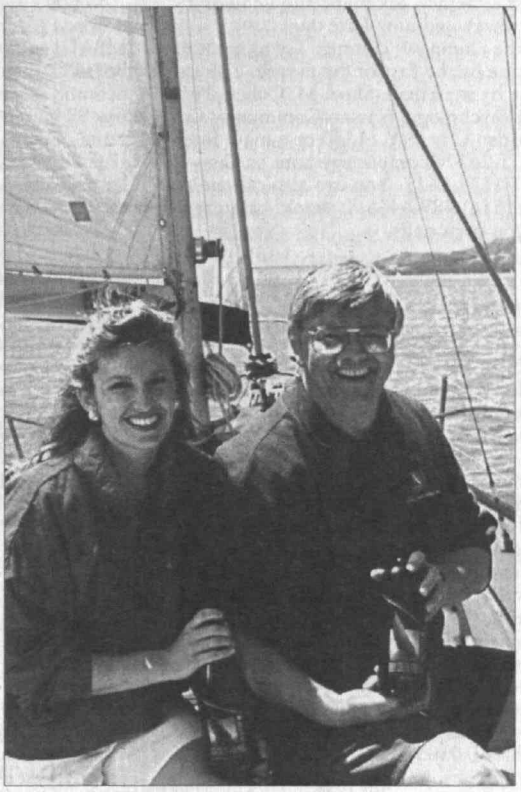
When *phylloxera* devastated European and California vineyards 100 years ago, native American rootstocks were used for replanting. Some industry observers say that

those rootstocks were not as resistant as once believed. The French have long maintained the vines widely used for replanting in the United States are suspect, says Stare, and French viticulture schools recommend against using them. Others say the current northern California epidemic involves a new biotype of the pest.

It takes about three years for the parasite to have an impact on the grapes whose vines they have invaded. In the immediate term, on their own 110 acres, the Stares are doing the same as other vineyards—tearing up infested vines, fumigating, and replanting with more resistant vines. But at a cost of $15,000 per acre, they're only able to replant a dozen acres a year.

They are optimistic about the future, nonetheless. Kim Wallace believes that the blight could eventually result in better-tasting wine. If winegrowers plant varieties suited to each microclimate, she says, the different qualities that are brought out in the grapes by different soils can result in richer, more complex wines. And her father notes that the forced replanting also gives vintners an opportunity to fine-tune their mix of grapes to meet current tastes in wine, as well as use improved methods that will produce a better yield.

—Susanne Fairclough □



This Bug Creek Vineyard label (upper left) with its caricature of the root louse, **phylloxera,** ***is helping to educate the public about a plague affecting California vineyards. Bug Creek Rosé is produced by the Dry Creek winery of David Stare, '62. A percentage of the profits from the wine will go to fund research on louse-resistant rootstocks, through which Stare hopes to "stamp out mutant grape-killers!" (Above) Stare enjoys the sport featured on his classic Dry Creek label (far left) with his daughter, Kim Stare Wallace, vice-president and director of marketing for the winery.***

that President Charles Vest of MIT was gracious enough to respond in a letter in December, 1992, to Ted's concerns regarding the state of undergraduate education at MIT, which he addressed to Dr. Vest at our 30th reunion in June, 1992.

Stan Jacobs sent me a copy of his article on "A Recent Sea-Ice Retreat West of the Antarctic Peninsula," which appeared in *Geophysical Research Letters*, Vol. 20, No. 12, pages 1171–1174, June 18, 1993. Stan's article was used as the major source of a news article in the *New York Times* on Tuesday, July 6, 1993, by Walter S. Sullivan, entitled "A Vast Polar Ice Sheet Mysteriously Vanishes." Stan works at the Lamont-Doherty Earth Observatory of Columbia University at Palisades, N.Y., and can be reached via e-mail at rosssea@lamont.ideo.columbia.edu

While I am losing my direct connection to the engineering computer here at UAB, you can still contact me through MIT1962@mitv-ma.mit.edu or via MCI Mail at 0004241803@mcimail.com I will pass along my new e-mail address when we get our new computer lines installed. In the meanwhile, I can be reached at: **Hank McCarl,** secretary, P. O. Box 352, Birmingham, AL 35201-0352

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Dan Spiers, XXI, is alive and well and living in Paris! His office at UNESCO overlooks l'Ecole Militaire and the Eiffel Tower. He and his wife, Cecily, have two children, Gabrielle, about 14, and John, about 10. They live near Versailles. Dan's work involves considerable traveling, but rarely to the United States. Thanks for this alumnews to Doug Tuggle, '64, XV, who met Dan this summer. He says Dan still looks the same, except for a new beard.

Allen Weill, XVIII, has been elected to the partnership in KPMG Peat Marwick. He manages the general insurance consulting practice, specializing in financial strategy. He and his wife, Marcy, have two sons, David and Edward.

Don Dreisbach, XXIB, writes that he has published his first book, *Symbols and Salvation.* It is published by University Press of America.

Since this is all the news I have received, let me take this opportunity to use editorial prerogative and introduce myself with the first bio info I've ever written to the *Tech Review* since we graduated. You should do the same; otherwise, I'll have to keep filling this column with self-aggrandizement. Could I do it? Do you know the Energizer rabbit?

I graduated in VII and stayed to get an SM with the new graduate psychology department at MIT. I then enrolled in the PhD program in physiological psychology at SUNY Stony Brook. After embarking on an interminably long research project for a dissertation, I woke up one morning and said to myself, "Cohen, you're in the 23rd grade. Don't you think it's time to finish?" Six months later I had my degree. My research was well received and I was invited to Warsaw to present it to an international symposium on frontal lobe function and behavior. Interests shifted however, and after an internship, residence, and four-year postdoctoral program, I became a psychoanalyst. By this time I was nine days shy of turning 36 years old and had been in school for all my life but the first five years and the one year after my PhD. Today, I'm in private practice. I'm also on the staff of Brookhaven Memorial Hospital and last year, as behavioral science educator in the Family Practice Residency Program, I tried to teach physicians

to understand and treat the whole patient, not the angioplasty in 302. This is my 26th year teaching psychology at Nassau Community College where I am a full professor. My son, David, is now 26 and is a graphic artist at Hyperion Books, a Disney company in Manhattan. I've been divorced since 1979. Nancy, my POSSSLQ (the census bureau's acronym for person of opposite sex sharing same living quarters), and I have been together for two years now. My interests are scuba (I'm a Master Diver) and sailing. Two years ago, a sailing friend and I doublehanded his 42' cutter-rigged sloop 5,000 miles across the Pacific from Panama to Tahiti.

And how did I become our class secretary? I was on a bus after being talked into going to the reunion dinner dance by AEPi brothers **Elliott Bird, Steve Bernstein,** and **Marty Eisenberg** and their wives Toby, Stephanie, and Esther. **Phil Marcus,** our outgoing secretary who did such a fine job writing this column for the last 10 years and whom I had never met, was on the bus with us also. He was so outgoing that the next thing I knew, I was the new class secretary. Six munz ago I couldn't spell secretary and now I are one!

Keep the alumnews coming. Try to get it to *Tech* or me by the first of the month. You can reach me by snail mail: **Shoel M. Cohen,** PhD, Dept. of Psychology, Nassau Community College, Garden City, NY 11530 or e-mail: Internet 71271.2627@compuserve.com or Compuserve 71271,2627. You can also call me at home at (516) 489-6465. It would be great to talk to you personally.

64 30th Reunion

Happy New Year! May it be healthy and prosperous for you and your families.

One lonely item to report. A news clip from *The Wall Street Journal* indicates that **John Hanson** has been elected to the board of directors of the Manville Corp. He serves as president of the Mining Machinery Division of Joy Technologies, Inc., in Pittsburgh.

I still don't have any firm dates for our 30th Reunion at this point. Preliminary information suggests that Technology Day, etc., will be held during the last three days of May and the first couple of days of June. Sometime in that period is a good guess for the reunion. In any event, make your plans to be in Boston around then. Meanwhile, best wishes for 1994. Please write!—**Joe Kasper,** secretary, RR 2, Box 4, Norwich, VT 05055

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Bob Szpila wrote to report that he finally got married on July 24 for the first time. His new wife, Tina, is in mortgage banking. Bob and Tina will continue to live in Irvine, Calif., where he continues a 20+year career with GenRad.

In the event you ever need a criminal lawyer in Texas, **Dave Disher** may easily be your choice. Dave retired from the technology world in the late '70s after a successful career and decided to go into law. He lives in La Marque, Texas ("we have the largest dog track in the world"), with his second wife and stepdaughter, and focuses 90 percent of his time on criminal law—largely appeals cases—as an individual practitioner. Dave has been listed in *Who's Who in American Law* the last several years. His children by his first marriage, Karl and Carol, are both grown and living in Austin. Dave tries to keep touch with **Joseph Hachme** when he is in the United States and is looking forward to our 30th Reunion next year.

With my interest in commercializing materials companies, I was delighted to talk with **John Groves** recently. John got a PhD at Columbia, taught at the University of Michigan for 16 years, and then moved to Princeton, where he has headed the Chemistry Department for the last five. Princeton is in the middle of a major funding effort to celebrate its 250th Anniversary, and biological chemistry is a major focus—which is John's area. His own work has focused on learning how human enzymes might be mimicked in chemical catalytic systems—with particular interest in oxidizing petroleum products. John and his wife have been married 27 years now, and their older child is a second-year graduate student in biophysics at Stanford and their younger a sophomore at Princeton. John was named to the American Academy last year. He reports keeping touch whenever possible with **Roland Cannon** at Berkeley.

Now the big dollar story. **John Roach** (he dropped J.D. when he went to Stanford for an MBA) was in the news last summer when Fibreboard Corp., the $240M (sales) building products and ski resort company he runs agreed to pay $3 billion (yes, billion) to settle asbestos claims against Fibreboard. John had been a senior executive at Manville, which had a similar problem, before joining Fibreboard, but felt the Fibreboard case was different—and offered a reasonable chance of solution. John and I were in Jay Forrester's program together at MIT. He reports he remarried 11 years ago and inherited 3 stepsons and now has 2 granddaughters. His wife is an interior designer and author (children's books). He tries to maintain a wide range of sporting activities—running, cycling, and skiing—but concentrates on skiing, as Fibreboard owns both the North Star and Sierra Ski resorts in the Lake Tahoe area.

I regret to report the death on June 15, 1993, of **Stephen Schmelzer.—George McKinney,** 33 Old Orchard Road, Chestnut Hill, MA, 02167, phone: 617-890-5771, fax: 617-890-3489

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Stephen R. Weiss writes that he is still in Ann Arbor working for Comshare as he has since 1966. His older son, Jonathon, '93, Course VI-3, works for MIT at DCNS. Younger son, Jeremy, just entered the Cornell School of Engineering and also plans to major in computer science. Jeremy plays trumpet in the Cornell "Big Red" Marching Band. Stephen and his wife, Steffi, are enjoying the empty nest. . . . **Dan Dedrick** is newly wed, to the first person to whom he had proposed (a quarter century ago), Frances Silverman from North Hall Simmons. His eldest child, Ben, is a freshman at the American University in D.C. Frances' daughter, Maggie Cohen, is a high school sophomore, and Dan's two daughters, Rebecca and Alexandra, are in seventh and third grades respectively. Dan is on the faculty of Harvard Medical School, continuing to run the Brigham and Women's Hospital residency program in anesthesiology. . . . **Michael D. Rinaldi** has left DEC to become vice-president for operations at Textron Specialty Materials in Lowell, Mass.

Thomas B. Jones e-mailed a "catch-up on all the years since graduation" note. He stayed on at MIT, receiving a doctorate in EE in '70.

He and his wife, Mary, then moved to Fort Collins, Colo., where he taught at Colorado State for 11 years. There his two daughters, Laura and Audrey, were born *exactly* four years apart. In 1981, they moved to Rochester, N.Y., where Tom spent three years in industrial research at Xerox before returning to teaching at the University of Rochester. He now teaches electricity and magnetism and conducts research in bioelectricity, xerographic physics, and related topics. He and Mary have taken up ice dancing and ballroom dancing for the fun of it. Mary works for a career consulting firm and travels a lot. Their older daughter is a sophomore at Tufts with strong interests in the Japanese language and their younger daughter is a high school sophomore and volleyball enthusiast who played varsity as a freshman.

My daughter and I completed our hike on the Appalachian Trail in Vermont. We actually went the whole route as planned even though we woke to an unexpected frost one morning. After coming off the trail we were told that the temperature had plunged to 25 degrees that night. Next year we hike in the summer with no mountains. . . . Tom Jones noted that it was the "e-mail connection" that finally got him to write. Hope it encourages more of you to do the same.—**Eleanore Klepser**, secretary, 84 Northledge Dr., Snyder, NY 14226-4056, e-mail: vismit66@ubvms.cc.buffalo.edu

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George Howison is now president and CEO of Meridian Oil Inc., a subsidiary of Burlington Resources, in Houston, Tex. . . . **Carleton Bryant** is currently serving as executive VP and chief operating officer at Westerbeke Corp. of Avon, Mass.—Sharlotte and **Jim Swanson**, secretaries, 878 Hoffman Terr., Los Altos, CA 94024

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Please send news for this column to: **Gail** and **Mike Marcus**, secretaries, 8026 Cypress Grove Lane, Cabin John, MD 20818

69 25th Reunion

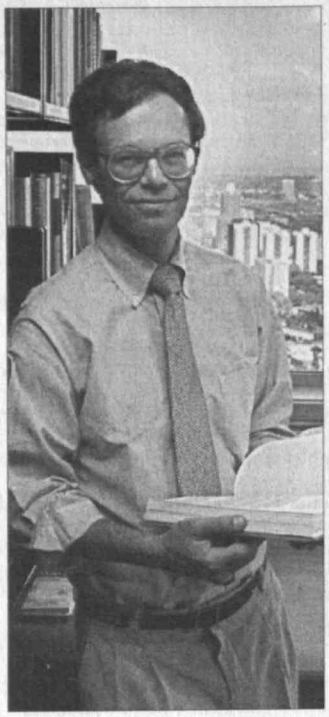
Third reminder: Our 25th Class Reunion is fast approaching—June 2–5, 1994. Please reserve those dates for an outstanding time!

Dick Hodgman writes from Leawood, Kans.: "Every issue of *Technology Review*, I enjoy turning to the Class Notes. So I decided it was my turn to contribute. After graduation, I stayed in the Boston area working for Memory Technology, a small electronics company co-founded by MIT grad Jon Sirota ('64), working there with **Dave Cane** ('69). I left just before the recession of 1974–1975 killed the company, moving to Sunnyvale, Calif., to work for Intel. I designed and then managed memory system development, then worked in microprocessor development. While I was in that group, IBM picked Intel and the 8088 for the IBM/PC; although we knew it was a big win for Intel, it turned out also to be history in the making.

"In 1982 I moved to Tandem Computers in Cupertino, Calif., managing disk development. We developed the first products with large numbers of drives in one cabinet, forerunners of today's disk arrays. I also managed Engineering Operations and held several staff positions. While at Tandem, I worked with many MIT folks, including Armen Varteressian ('68), Frank Sheeman ('68), and Steve Hayashi ('66). In 1991 we decided to make a change and moved from California back to my home town of Kansas City. I have started an electronics/computer management consulting business here, and have worked for several companies in Kansas City as well as my former employer, Tandem. I have joined the MIT Educational Council, interviewing prospective MIT students. It's a great opportunity to express my continued enthusiasm for MIT.

"Before I left Boston, I met my wife-to-be, Lynne (Gozonsky), (Brown '71). We married in California in 1976. We have two children, Lucy, 8, and Thomas, born in January 1993. After eight years, we had forgotten how busy a baby can keep you! We are planning to come to the 25th Reunion in the spring and hope to see many classmates."

Austin Napier appears to be at Tufts University, judging by his return address—"Physics Department, Medford, Mass." He writes: "I am happy to report the birth of my son, Alexander Benjamin A. Napier, on September 1, 1992. Linda and I are tired but happy! Hope to see some other youngsters at the 25th Reunion." It is unclear whether Austin is referring to "youngsters" who in their mid-40s can deal with babies, or the wee ones themselves! . . . An eloquent letter from the famous Dr. **Jeremy K. Raines** of Raines Engineering, Potomac, Md.: "Following up on one of my few remaining fantasies, I began flying lessons last June. I got a 97 on the FAA written exam,



Richard Goodman, MD, '70, director of the Vollum Institute for Advanced Biomedical Research at Oregon Health Sciences University, Portland, is one of two Oregon scientists to receive the Discovery Award. This $5,000 award, given by the Medical Research Foundation of Oregon, recognizes and helps support physicians and scientists who are making distinguished international contributions to life-saving and life-prolonging biomedical research. Goodman and his associates won the second largest grant in OHSU history and the university's largest in 25 years. The five-year, $5 million project grant focuses on molecular pathways allowing nerve cells in the brain to communicate with one another. Because thoughts and feelings emanate from the complex interactions between trillions of the brain's nerve cells, implications for these studies are vast. Ultimately, the research team hopes to identify mechanisms inside cells that allow signals from the exterior to control gene expression. This is a key to understanding serious irregularities in the nervous system, such as mental illness, drug addiction, movement disorders, and senile dementias such as Alzheimer's.

which reflects well upon the quizmanship skills learned at MIT decades ago. Though I'm supposed to be training in a Cessna, I seem to be flying mostly in antique biplanes: I have done wingovers in a 1941 Waco Army Corps trainer, and barrel rolls and dives in a 1939 Stearman Navy trainer. Is this a midlife crisis or something more serious?" One of his "few remaining fantasies?" C'mon Jerry, you're not that old!

As I prepare these notes in late September, I am looking forward to a trip to Maui in early December to attend the Fourth International Conference on Cold Fusion ("ICCF4"), sponsored by the U.S. Electric Power Research Institute. Aero/Astro classmate **Dean Musgrave** also will attend, and we have teamed up to split a time-share condo in Kihei. Since the silence in the U.S. media about ICCF4 is likely to be deafening, I just thought you should know.

Keep those great letters coming and let's see you all at the reunion!—**Eugene F. Mallove**, secretary, 171 Woodhill-Hooksett Rd., Bow, NH 03304

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Alex Sarris is co-author of *Economic Policy and Household Welfare During Crisis and Adjustment in Tanzania*, recently published by New York University Press. Alex, who is a professor of economics at the University of Athens, in Greece, has been a consultant for the World Bank, the Food and Agricultural Organization of the United Nations, and the International Fund for Agriculture Development.

Ray Kurzweil has become a member of the Board of Director of Wang Laboratories. He continues to run his own firm, Kurzweil Applied Intelligence, Inc.

Our personal news is that Greg has changed law firms. He is now a partner at Kaplan & Kilsheimer. Please send us your news as well.—**Greg** and **Karen Arenson**, secretaries, 125 W. 76th St., Apt. 2A, New York, NY 10023

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Harriet Burris is still practicing emergency medicine at the Shoreline Satellite Facility of Middlesex Hospital in Essex, Conn. She is also the librarian for the Handweaver's Guild of Connecticut. . . . **John Burris** has been primary homemaker since his company moved south in 1989. Liz, 13, and Katy, 11, are busy with school and dance.—**R. Hal Moorman**, secretary, P.O. Box 1808, Brenham, TX 77834-1808

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Please send news for this column to: **Wendy Elaine Erb**, co-secretary, 6001 Pelican Bay Blvd., Apt. 1001, Naples, FL 33963

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Way back when we were undergrads, one's fraternity affiliations were a source of identity and gut-wrenching competition. As a Phi Delt, we had our friendly rivalry with our friends at SAE, particularly around Rush Week when we constantly scrapped over the same freshmen. But times change and tempers mellow. A letter from **Steve Waller** reminds me that, knowing half of the folks he writes about, I'd have been glad to have been with him when, as he says, "we were privileged to entertain, on the evening of June 5, 11 brothers of SAE from the far reaches of the civilized world, assembled to renew old friendships. I would estimate that it took as long as two or three minutes to reestablish the rapport we had in 1969–1973.

"The gentlemen were **Nate Rudd, Rich Haas, Mike Scott, Bill Decampli, Stu Traver, Bill Godfrey, Steve Cochi, Bill Dannelly, Frank Kiel**, and **Thad Tanley**. Telephoning regrets were **Steve Williams, Dave Sebolt, Bob Keeth**, and **Tom Hundley**. In view of the robust appearance of those attending, I would suggest that some of us will be present at the diamond anniversary of our graduation."

What is startling is how many of these pledge brothers I remember well. Rich Haas was a McGovernite when I was a Nixonian, Bill Decampli was in the Logarhythms with me for a while, Steve Cochi was at Duke Medical School when I was down the road at UNC Med School, and Bob Keeth and I shared four years on MIT's sterling golf team. I would gladly put down my fraternal rivalry to pick up a cold draft with these men.

In other notes of significance, **David Boucher**, chair of Interleaf, has been named to the board of directors of Wang Laboratories. . . . **Eric Hoffman** was named executive director of the American Philosophical Association. Based in Newark, Del., the association, 9,000 strong, promotes the exchange of ideas among philosophers and encourages creative and scholarly activity in philosophy.

Write!—**Robert M.O. Sutton, Sr.**, secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

74 20th Reunion

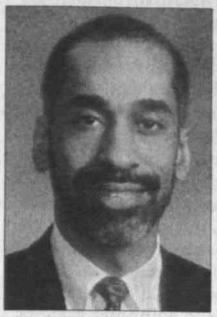
It's ironic. I was supposed to write this column this evening. I was thinking to myself, "Nobody reads it; nobody says 'thank you;' why bother?" You know how you get when you're tired at the end of the day, when in the mail comes this letter from **Jim Olson**. Talk about well timed! Jim and I were buddies starting with rush week (though we went to different living groups), and the last time we saw each other was our 10th Reunion in 1984. Jim enclosed a picture of himself (which he threatened me with murder if I printed) and a picture of me taken 10 years ago. This picture (which you will also not see) puts to rest a worry I've had for more than a year. This picture is actual proof that my body is not going bad now that I am more than 40 years old—it proves that my body has always been going bad.

Jim wrote a 20-year summary on one side of a page. He's living in Indianapolis. He's got a small design'n'build shop for specialized electronic controls. "We're proud of the work we do," and business is good. He has two boys and three girls from his first marriage, and his present lady has two of her own. Only regular contributions of news will atone for your sinful 19-year silence, Jim, but thanks for the photographs.

Robert Dutton has been appointed VP and general manager of Strategic Communications at GTE Government Systems Corp. in Needham Heights, Mass. Robert and his wife, Jean, live in Bedford and have three children—Kelly, Bobby, and Chris. . . . **Joseph Fernandez** has become president and CEO of the Buttrey Food and Drug Stores Co. Joseph caps a career in the food retailing industry. Buttrey operates stores and three distribution centers in five states in the Northwest.

Robert Dutton

News from the Baylor College of Medicine tells of **Donald Wesson** being honored this



Donald Wesson

year for his "outstanding contributions and commitment to education and to student guidance." The award was given in a vote by the medical school's graduating class of '93. . . . Regular readers of *Forbes* magazine will know at least the face of **Peter Huber**. Your faithful scribe himself recalls Peter on the soccer and tennis courts of his youth. Peter wrote a book in 1991 entitled *Galileo's Revenge: Junk Science in the Courtroom*, and it has become a standard for measurement in product liability cases when trying to provide some guidelines for the use of scientific evidence and testimony in federal court.

See you at the reunion, and write!—**Lionel Goulet**, co-secretary, 115 Albemarle Rd., Waltham, MA 02154-8133

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Please send news for this column to: **Jennifer Gordon**, secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036; or 18 Montgomery Place, Brooklyn, NY 11215

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From the mails: **Richard Mulligan**, a member of the Whitehead Institute for Biomedical Research and a biology professor at the 'Tute, is the first recipient of the American Society of Biochemistry and Molecular Biology award. The award, established by Amgen, Inc., is for achievements in using biology and molecular biology in understanding diseases. Richard has devised methods for transferring genes into mamalian cells using a virus as the vector to carry the foreign genes. Prior to this award, Richard received the MacArthur Foundation Prize in 1981, the Scarle Scholars Award in 1983, and the 12th Rhoads Memorial Award in 1991. In 1992, Richard was the co-recipient of the Science Council Teaching Prize at MIT. Well done!

Daniel Christman writes: "The Christman household has grown from one to two since last year's news tidbit, and will probably grow to three by the time you actually read this! Yes, it's true. I got married last summer (July 25, to be exact) in Calais, Maine, in conjunction with a family reunion to commemorate my grandfather's 95th birthday on July 23. My wife's name is Christina Christman, the kind of name no sane mother would give her daughter! We anticipate celebration of our first anniversary with a child due July 23. My grandfather is thrilled with the prospect of having a great-grandchild on his birthday. Of course, babies don't always arrive as scheduled—Christina does not mind sharing her July 20th birthday but is adamantly opposed to sharing our anniversary with the youngster!"

Mary Raynak, AIA, has been appointed an associate at Fanning/Howey Associates of Celina, Ohio. They are an architectural, engineering and consulting firm. He has been with the firm since 1990, and has been extensively involved in CADD design, 3-D modeling, computer visualization studies, and CADD marketing presentations. Mark is a member of the American Association of Architects, and with his wife, Kyle, and three children, live in New Bremen, Ohio.

From **David Littleboy**, who earns his living in Tokyo as a translator, we have a letter and the latest copy of his publication *Expatriate Ledger*. He writes: "Translation has been wonderfully stable over the last three years, but the yen inflating and the economy fizzling, who knows? With the Japanese government refusing to set any kind of import goals, and also refusing to engage in any pump priming, the yen can only continue to rise. The result: a $50 (when in New York) Walkman is over $200, if you make the mistake of buying it in Tokyo. Very strange." Space limitations prevent your secretary from quoting extensively from the *Expatriate*; however, the beginning of the Summer 1993 issue is a must: "Trade. I like to claim that Japan is physically located on the planet Earth, but with the recent shift in the exchange rate, the cost of living in Tokyo would indicate that one is actually living on the moon. My neighbor had her house painted: $10,000. Four stops on the subway: $2.25. One grapefruite: $3.10. Two ears of corn: $5. A gallon of milk: $8. An extremely generic haircut: $30. It goes on and on. The change in the rate, from about 125 yen/dollar to about 105 is only about 16 percent, but it has changed a bad situation into a ridiculous one." The balance of this particular article discusses Japan's trade balance and terms of trade with the U.S. and is a well written, cogent discussion of the current state of affairs and the probable path of events in this area.

For anyone interested in Japan, its politics, economy, and follies, your secretary strongly recommends subscribing to David's journal. He is extremely insightful about the workings of Japan and timely with both his observations and forecasts. You may reach him at: Qtech Translation, Ltd., 17-4 Minami Motomachi, Shinjuku-ku, Tokyo 160, Japan.—**Arthur J. Carp**, secretary, Quantalytics, Inc., 220 Henley Rd., Woodmere, NY 11598-2523, (516) 295-3632, fax: (516) 295-3230

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Gee whiz, gang, this is *not* the place where "no news is good news"! We are starting the new year dredging the bottom of the mail bag for cards and letters I missed last issue. Let's see, the first one I pull out informs us that **Cynthia Koelker** is in private (medical) practice in Akron, Ohio. She has finally moved her family into a bigger house. She laments that she never seems to have time for a vacation, but she would welcome guests or phone calls. . . . Next, we find a jotting from **Richard Baer** who also shares his lamentations. He reports that he wishes that he had gone Course VI-A when he had the chance at the Institute. He had the pleasure of mentoring Pratima Rao, '93, through her VI-A master's thesis at Hewlett Packard Labs, and he met a fellow Chi Phi brother, Misha Davidson, '95, through the VI-A program.

Now since the bag appears to be empty, I will wrap up this slow news month with the announcement of my successful completion of a course in principles of real estate and my even more exciting passing of the Virginia State Real Estate Salesperson Licensing Exam. A scintillating career awaits me, I am sure! I have affiliated with a local Century 21 office and expect to work when the children are in school, evenings, weekends, etc. We need your news! Write to **Ninamarie Maragioglio**, still at 8459 Yellow Leaf Court, Springfield, VA 22153-2522; e-mail to hertz@xip.nrl.navy.mil

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Your class secretary and wife Diane Curtis are proud to announce the birth of Hannah Nicole Bidigare-Curtis, born September 20, 1993, at home. We elected to have a home birth for a number of reasons, philosophical and medical. The interesting statistic is that there are significantly fewer complications with home births than with hospital births. This is due to better pre-natal care provided by midwives, screening for risk factors and the referring of high-risk deliveries to the hospital, and enhancement rather than interference in the natural process of childbirth.

Almost-3 Danielle and almost-2 Luke were entertained by Barney during the two-and-one-half hour labor, as our child-caregivers didn't arrive until after the birth! (The midwife made it only 20 minutes before the birth!).

The demands surrounding this blessed event and those of the fall harvest keep me from conveying the usual news of classmates and postpones the second chapter of my reunion post-mortem.

All the best to classmates during the holiday season.—**Jim Bidigare**, secretary, 9095 North St., Rd., NW, Newark, OH 43055-9538, (614) 745-2676

79 15th Reunion

Happy New Year! The good news is that we have all made it through another year. The bad news is that *no one* has written a thing since the last column. Please drop me a line and let me know what's new and exciting in your lives (or even what's old and boring—at this juncture, I'll print anything!) And don't forget our 15th Reunion coming up in June. Hope to see you there.—**Sharon Lowenheim**, secretary, 98-30 67 Ave., Apt. 6E, Forest Hills, NY 11374

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Charles Wilson and his family are now living in Georgia. The chance to lead the stability and control of the Lockheed F-22 Advanced Tactical Fighter proved irresistible and helped overcome their mixed feelings about moving from California. Charles says the job is "almost" as challenging as coping with a 4-year-old and 1-year-old twins!!

If you are visiting Raleigh, N.C., and need a patent attorney, call on **Robert Glatz** at Bell, Seltzer, Park, and Gibson. Robert and his wife Michelle Lucier Glatz, '81, have two children: Shannon (4), Brittany (2), and a third that was due July, 1993. Congratulations on your new addition—send us the details! Robert serves as the secretary of the new MIT Club in the Research Triangle area.

Carol Julin and her new husband, Alex Ng, took advantage of the record snow in Boulder, Colo., last year to do lots of cross-country skiing. During the warmer months they enjoy wonderful hiking and rock climbing. When not playing in the great outdoors Carol works in a lab in the Molecular Biology Department while Alex completes a postdoc in the Kinesiology Department.

Emerson Yearwood writes that he is cur-

rently assistant secretary of Automated Sciences Group, Inc. He also serves on the board of directors of D.C. Habitat for Humanity.

An e-mail message from **Ed Chang** brings us up to date on his activities since graduation. Ed has earned MA (education) and MS (operations research) degrees from UC/Berkeley. Before 1988 he taught high school math, helped run a now defunct chess tutorial software company and worked with the inventors of "portfolio insurance" (long before the stock market crash of 1987). Since 1988 Ed has developed linear/integer programming models for capital equipment (mostly commercial aircraft) leasing deals. After 12 years in the San Francisco area, he moved back east to accept a position with one of the two 'major' (10 employees) software companies that address this niche. Interet is located in Millburn, New Jersey. You can send Ed e-mail at uunet!interet!ed.

I received a nice letter from **Cynthia Reedy**, who is teaching middle school science at Hebron Academy in Maine. Cynthia lives in Norway, Maine, with her husband, Brad Cummings, and three children: Charlie (4 1/2), Claire (2) and Tommy (6 months). It sounds like a beautiful and peaceful place where deer graze at their apple trees and they fall asleep listening to owls and loons. Cynthia writes there is plenty of room for visitors and tents! She visited **Connie West** a few times last year while she worked in Portland, but Connie has moved south again. **Audrey** (**Greenhill**) and Paul **Jones**, '79, are frequent guests. Audrey is great at reality checks: Did 18.01 really prepare me for ear infections and chicken pox?! In answer to Cynthia's question to me regarding our move to our new home "Are you, by any chance, ever unpacked?" It's only been two months—ask us a year from now (I'm sure the answer will be NO!).

I hope you all have a safe and happy holiday season. Drop me a line at: **Kim Zaugg**, secretary, 549 Fairfield Road, Canton, MI 48188, vayda@erim.org

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Please send news for this column to: **Mike Gerardi**, secretary, 3372 Olive St., Huntington Park, CA 90255, (213) 587-2929 (h), (310) 553-5050 (w)

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Thanks for the letters this month!

Peter Rogers just wrapped up a four-year assignment as part of the busiest launch team in the world at Space Launch Complex 17 on Cape Canaveral AFB. En-route to his new assignment as deputy chief of staff for science and technology in the headquarters of Air Force Material Command at Wright Patterson AFB, he and Rose spent a month touring Europe.

Matthew Kallis has his own investment management firm called The Crescent Group and just recently started his own mutual fund. He and his wife, Susanne, have two kids, Samantha (in kindergarten) and Amanda (22 months). Matthew has been very active in the MIT club of Southern California and has been the VP of programs and young alums. They bought their first house about a year ago.

Jeffrey Lukas joined the Tri-River Family Health Center in August as a pediatrician. He recently completed his military service obligation at the U.S. Air Force Base in Altus, Okla.

Walter Luthiger is now stationed as a Nuclear War Plan Advisor to the Commander in Chief of the United States Strategic Command. Previously he had a tour of duty as Weapons Officer and Navigator/Operations officer on the USS *Chicago*.

I recently ran into **Patrick Houghton** at a Churchill Club meeting in Silicon Valley. Patrick and his wife recently bought a house in Petaluma.

As for me, I just started my own business doing marketing consulting to high tech companies.—**Helen** (**Fray**) **Fanucci**, 502 Valley Forge Way, Campbell, CA 95008 e-mail: pdalady@aol.com

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Ken Krugler married Chris Duff in a lovely wedding in Carmel, Calif., on September 11, 1993. Classmates attending included **Kristin Foss, Chris Schneider, Jeff Muss, Mike Santullo**, and your humble scribe. Other Delts at the wedding were Rich Kosowski, Scott Davis, '82, and Glenn Stump. The couple was married at Clint Eastwood's Mission Ranch overlooking a pasture of sheep and the Pacific Ocean. Two days later, Ken and Chris traveled to Indonesia for their honeymoon.

Nobody sent in any other news this month. Please give us an update, or you'll be reading a lot of news about Delts.—**Jonathan Goldstein**, secretary, TA Associates, 45 Milk St., Boston, MA 02109

84 10th Reunion

Our 1992–93 Class of 1984 scholarship fund recipient is Carolyn M. Fenech. Carolyn is from Waterbury, Conn. and is a MechE. She is a member of SWE, the Biomedical Engineering Society, the Deaf Studies Club, and Habitat for Humanity. She has volunteered as a tutor for the Cambridge Public Schools and various area shelters and soup kitchens. Carolyn has been working in UROP projects including: assisting in the design of a mobility aid for paraplegics and the study of human tremors. She is a senior this year and enjoys field hockey and running.

Charlie Marge has moved on to Cleveland Consulting Associates in their Decision Science Practice after spending six years with Arthur D. Little. Charlie is assisting clients with software for manufacturing and distribution scheduling. He works out of CCA's new office in Waltham.

John McCrea received an MBA from Stanford's Business School. Before this, John had worked in MIT's treasurer's office, at BU, and for a private school in Portland, Ore.

Oren Levine is returning to Boston, after almost six years in Israel, to go back to school. He has spent the last four years working at Indigo, Ltd. in Rehovot, Israel, supporting the company's CAD system. Oren writes: "After all this time in the field, I figured it was about time I learned more about it. I'll be at Northeastern, doing a master's in computer systems engineering. This means I'll be in town for the 10th Reunion next year. My other half, Dorit Zuk, will be joining me in the area in January or so, to start a post-doc in molecular biology at UMass in Worcester. She first has to finish her doctorate at the Weizmann Institute here. We'll probably end up living at one end of the Worcester-Boston axis; we haven't decided yet who's going to have to commute."—**Howard Reubenstein**, secretary, 28 Mitchell Grant Way, Bedford, MA 01730, 617-275-0213 (home), hbr@mitre.org

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Please send news for this column to: **Bill Messner**, secretary, 5927 Alder St., Pittsburgh, PA 15232, (412) 361-4180, bmessner@andrew.cmu.edu

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Sorry about the short column. I didn't get much news, and we're wallpapering the baby's room. Please write.

Eric Ginsburg received a PhD in chemistry at Caltech. He has taken a job at Kodak in Rochester, N.Y., and gotten married to Sandra Gustafson. . . . **Karl Tucker** stopped by for dinner during his post-B-school travels. He graduated from Harvard this past June and will be working at Strategic Decision Group in Boston. Karl passed on some news about **Tom Paterson** and **Chris Da Cunha**. Tom is still in Palo Alto and was married in Denver this summer. Chris works for Alex Brown in San Francisco and also got married this summer. All sound like they're doing quite well.

Ellen Epstein took a few weeks off from Morgan Stanley to tour Hong Kong and Bali. She, along with **Karen Wohl** and **Anne Fricker** (and, I assume **Ray Schmitt**), have been trying to coordinate a weekend road trip down to DC so they could laugh at me while I was nine months pregnant. Fortunately, trying to coordinate their schedules is about as easy as saving a snowball in August. Needless to say, I'll probably see them when they baby's about six months old. Karen is still working for Merrill Lynch, and Anne is still at Thinking Machines (who, by the way, provided the computers for *Jurassic Park*—we caught it during the closing credits).—**Mary C. Engebreth**, secretary, 21305 Arrowhead Ct., Ashburn, VA 22011, (703) 729-6568

87

Hope everyone had a good holiday! Again, the column this month is pretty long, because of the new Class of '87 e-mail system, and all of

the news generated by it. To get on board, please send your e-mail address to MIT1987@mitvma.mit.edu, or to me. Now, on to the news. . . .

I-Chun Lin was shocked to read in October's class notes that her former suite-mate Walid Nasrallah, '86, found Stanford boring, and transferred back to MIT. She is enjoying her sociology PhD work at Stanford much more than her Course XV work at MIT—though her classes in statistics, decision theory, and econometrics are not very different from her Sloan experience, or as she puts it... "IL(ove)TFP!" I-Chun would like to hear from any MIT alums now working in the field of sociology.

Steve Russell got a PhD in materials science from Cornell University last May, and is now a post-doc at Arizona State University. He keeps in touch with other Theta Xis, including **Jim Ferrara**, who lives in Seattle where he is finishing a PhD in chemical engineering at the University of Washington. He and his wife, Cathy, have a daughter, Samantha.

Laura Kotovsky wrote in from Pasadena, Calif., where she has moved to finish a PhD long-distance while she begins a post-doc at UCLA. Her husband is an assistant professor in mathematics at Harvey Mudd College. At the wedding of David Marcovitz, '86, this past summer (who married Emily Schoenfeld in Baltimore on July 4th), she saw **Daniel Saal**, who was married the week before in Mexico to Denise Dalma. Daniel is still working on an MD/PhD at Yale, while his wife is working on a PhD at Albert Einstein in New York. Also at the wedding were Eddie Gornish, '86, and David Brown, '86, as well as **Joyce (Licini) Vigneau**, who is still working for Lotus and living near Boston with her husband, Mike. Finally, Laura is interested in the whereabouts of any of her Burton 2 floormates who may be in the L.A. area.

A couple of coincidences. . . . While looking for a book on UNIX in the library, I noticed that classmate **Simson Garfinkle** recently wrote a book, *Practical UNIX Security*, in 1991. That next week, while on a trip to New York, I pulled out an *Omni* magazine from the seat pocket in front of me, and saw an article, also written by Simson, on "The Cars of the Future." He has also published articles in *Technology Review*. Are any others of us published in the mainstream media? If so, write in and let us know. . . .

To answer the question asked by **Greer Tan** in last month's column: **Charles Coleman** writes in to let us know that he ran in to **Susan Fields** at a UC/SF party in San Francisco last spring. She's engaged to be married to a Harvard guy who is a manager at Oracle. Susan and her fiancée are to be married in Susan's home state of Tennesee, and hope to settle in Palo Alto. Currently, Susan is working as a manager for Lockheed in Sunnyvale. Since turn-about is fair play, Charles wants anyone who knows the where-abouts of **Jeff Kung** to write in.

Linda Marinilli is temporarily in Austin, Tex., where she is part of a one-year government-wide training program called the Woman's Executive Leadership Program. Currently at SEMATECH in Austin, Linda is staying with **Linda Chao**, who is also assigned to work at SEMATECH (a chip consortium) as part of her job with Digital Equipment. Linda also saw Sharon Fox, '90, in Austin, who is finishing up a PhD in chemistry, and Bruce Kristal, '86, who is doing a post-doc in San Antonio. Since finishing Chem E. Practice School in December 1987, Linda worked for Gereral Foods in Tarrytown, N.Y. in the field of Shelf Stable Foods. As part of her job, she was able to travel to cities including L.A., Miami, and Chicago, where she was able to visit her sophomore-year roommate **Betsy Parker**. She is now with the U.S. Environmental Protection Agency, and plans to return to her post in Quincy, Mass., after she completes her program. In addition to work, Linda has (almost) learned to cross-country ski, and tries to make time for hiking and biking. Finally, Linda is interested in the whereabouts of **Karen Bardeen**.

After spending five years at the "lesser-known" university up the Chuck (River), **Jonathan Gruber** writes that he has returned to his roots at the 'Tute, this time at the other side of the lectern as an assistant professor of economics. Jonathan lives in Brookline with his wife of two years, the former Andrea Kauffmann. . . . **Arun Ram** reports that he finished a PhD in algebra at UC/SD in 1991. He then spent a year at MIT as a special post-doc, living with Paul Wang, '86, and Ken Dinndorf, '86. Arun is now starting his second year of an ordinary three-year post-doc at the University of Wisconsin. He is enjoying all aspects of his life in Madison, including teaching, reading, music, and good coffee. . . . **Doug Singleton** is in the process of finishing a PhD in physics, I believe from the University of Virginia. Doug was married to Justin O'Neil on October 2. . . . From the *Tech Review* office, we hear that Navy Lieutenant **Stephen J. Thome** has recently reported for duty with the U. S. Naval forces in London, England.

Finally, I received a long note from **James Cross** detailing his life since he graduated from

MIT. He was at Princeton for two years, where he got a master's in chemical engineering, and spent time doing grad-student things like drinking cheap beer from around the globe, crashing eating club parties, cooking Indian food with friends. Most important, he rode a motorcycle, which he claims was instrumental in securing the affections of Tracy Brown of Columbus, Ohio, to whom he is now married. At the 1990 wedding, several MIT friends were present, including **Raul Elias** (best man), **Cynthia Espersen** (bridesmaid), Paul Salinas, '86, and Peter Parnassa, '90. **Tom Zirps** was to have been a groomsman, but dropped out to go to Singapore for a few months. They spent a couple of years trying to solve the "two-body" problem: specifically, James was beginning a PhD in scientific computing at Stanford University while his wife was still studying at Princeton. This problem was eventually resolved by both of them terminating their studies with master's degrees, and moving to Columbus, where James is now employed with the Thermal Systems division of the Battelle Memorial Institute. Along the way, they have had two boys—Cameron Sean, born in June 1991, and Zachary Paul, born in November 1992.

Well, that's it! Have a good month, and keep me updated! **Jack Leifer,** secretary, 2703 Swisher Street #202, Austin, TX 78705; phone: (512) 472-7507, fax: (512) 472-7546, e-mail: leifer@ccwf.cc.utexas.edu or MIT1987@mitvma.mit.edu

88

I hope you all enjoyed the holidays and have plenty of news to share with your class. This will be my first Massachusetts winter since 1988 and I am not looking forward to that cold Boston wind. My only comfort is that I will not have to walk across the Harvard Bridge for pizza at Dinos. Now, onto the news. . . . **Willie Baldwin** and his wife, **Stefanie Wiggins-Baldwin** are now the proud parents of Jonathan Alexander, born on May 5. Jonathan is doing quite well and looks like both his parents. Willie and Stefanie got together with **Reggie Tucker** and his wife, Carol, over the summer. Reggie is working at HP in the Medical Products Division.

Kay Chevray recently started at Integrated Systems, Inc. in Santa Clara, Calif., where she is working on attitude control of a low earth orbiting satellite. She is also an officer of the MIT Club of Northern California, which keeps her very busy. Her husband, Pierre Chevray, '87, is working on an MD/PhD at Johns Hopkins in Baltimore. They hope to live together next year, but haven't decided on which coast.

Brad Fenton defended his PhD thesis in May and is currently trying to finish his last two years of medical school in Boston. This will be a big challenge since his wife, Cydney, and daughter, Victoria, are living in Denver! . . . **Jason Dunham** has been living in the S.F. Bay Area since graduation, and just got a master's degree in mechanical engineering from Stanford. John married Felicia Dimoff, '87, last year, and they are now living in Palo Alto. John frequently sees other TEPs, Senior House friends, and other classmates.

After graduating from Harvard Business School, **Carla Kapikian** did plenty of traveling before starting her new job at Chemical Bank. She is working in the Management Consultant Center in NYC. Carla just moved into a great apartment in midtown. So, Carla, when is the party? Carla saw **Lisa Ezrol** on the subway. Lisa is working at JP Morgan. . . . **Cheryl Sampson** graduated from Bethesda Medical School and completed her internship at Camp Pendelton Marine Base in California. Over the summer Cheryl was stationed in Japan, and traveled to Hong Kong and Singapore. Cheryl will be training to be a flight surgeon at the Pensacola Navy Base in Florida from December until June.

Mark Mabry and his wife, Paula, just bought a house in Bedford, N.H. Mark works at Lockheed Sanders in the Advanced Engineering and Technology Division. In August, Mark attended a conference in L.A. and visited with **Dan Dismukes**. Dan is employed by Boeing Helicopter and is currently on loan to Lear. . . . **Bill Stasior** was living in Silicon Valley working at Interval, but now Bill is back at MIT working on a PhD.

"Life is good" writes **Anita Beck**. She is in the sixth year of an MD/PhD program at Washington University in St. Louis. While in St. Louis she and Greg Scott, '86, were adrenaline junkies—skydiving one summer and bungee jumping the next. Halfway through the PhD part of her degree, Anita's thesis advisor decided to move to the University of Washington in Seattle. So, Anita is continuing her studies in the Pacific Northwest. She writes, "It's absolutely gorgeous country out here with skiing, hiking, camping, rock climbing, kayaking, white water rafting, and mountain biking. And these are only the things I've tried so far! "Anita is keeping up with her medical skills by volunteering once a week at a free clinic for homeless teens. When she finishes the PhD, she will return to St. Louis to do her hospital rotations. On a trip to a meeting at Cold Spring Harbor Laboratories on Long Island, Anita was able to get together with **Julie Safirstein**, who is enjoying her pediatrics residency at Children's Hospital of Philadelphia.

Thanks to everyone who sent news. Take some time, and let us all know what you are up to! By now, I have tried to send e-mail to everyone. If you have not received e-mail from me, please send me your e-mail address (if you have one), so I can add you to my list. Write to **Cathy Suriano Singer,** secretary, 131 Main Street, Andover MA 01810, or to singer@mit.edu

89 5th Reunion

It's not too early to start planning for our reunion—I hope everyone is considering coming.

I've gotten a few submissions for the class calendar, but I still need to beg for more, so please send those pictures or video tape (either VHS or 8 mm). All submissions will be returned. We'll be publishing the school-year calendar, which will feature pictures of classmates, families, and other alumni/ae events, shortly after the reunion.

The reunion committee is together (as of late September) and is working hard to plan a fun reunion. Graduation is May 27, 1994, and the reunion will take place from June 2–5, 1994. **Juli Lee** is the reunion chair, and among the members of the reunion committee are **Derek Chiou, Hugo Ayala, Kenny Ng,** and all the class officers. Juli has returned to MIT and is now in Sloan; Hugo is working at Apple, and Kenny is working at BBN.

Here are this month's list of people to please write in: **Brian Brown, Jeffrey Gealow, Virginia Merlini, Rebecca Smith, Morten Winther**. What are y'all up to? If anyone knows about any of these people or anyone else, please write in!

Howie Zolla finished his fourth year of PhD work in materials science at Harvard. Howie still likes it, but is starting to get anxious about when he might finish his dissertation and "fly free." Howie has a position as a resident tutor at Currier House, one of the old Radcliffe Houses. "It is often rewarding, but it has its ups and downs," Howie writes. Howie keeps in touch with the 'Tute in a variety of ways, including being vice-president of the Sigma Phi Epsilon Alumni Board. He sees Matt Galla, '91, and Jim Davenport, '90, at the monthly meetings. "This past year the board did a lot of work renovating the house and it looks great," Howie continues. To keep fit, Howie bikes 150–200 miles per week recently and intends to be in "killer shape for ski season which is just around the corner."

Howie has also done a bit of travelling to visit **Jeff Killian** and Amy Beerline/Killian (Wellesley '90) at their home in Washington State. They all skied at Crystal Mountain, Wash., and had a great time. Lieutenant Killian has one more year in the Nuclear Sub fleet and is doing well. Howie also spent the 4th of July in Lake Tahoe with many friends including **Roger Horton**. He and Roger had a great time mountain biking and hiking. Also, Howie still sails with his Sig Ep little brother Chris Jalbert, '90. Chris is coming back to Tech to finish his degree after working with a small startup for a couple of years.

Bob Trejo has finished Teach for America in Pasadena, Calif., and has moved back to New England with his wife, Kelli Trejo (Wellesley '90). Bob is starting Harvard Graduate School of Education to get a master's in Education in September.

Karl Dishaw is in Omaha, Neb., telling Air Force weather satellites what to take pictures of. "No jokes—Omaha's a great town with a really good music scene," Karl writes. Karl went to **Jean Kim**'s wedding last month and saw a lot of MIT folks.

Ron Koo attended the International Solid-State Circuits Conference in San Francisco this past week, and heard **Paul Yu** give a talk on his research. Ron had dim sum with Paul, **Ben Shih**, Ben's fiancée, and several others. . . . **Bill Maney** and **Angeli Salgado** were married on August 21, and will be living in San Francisco.

Leslie Liu will be going to Japan for 2 years. . . . **Doris Lin** is now engaged to and living with Daniel Kim, '78. They haven't set a date yet, but will be getting married in the next year or two. Doris has just started law school at the University of Southern California, and hopes to eventually go into animal rights law or environmental law.

K. Tibor Toth and his wife, Jennifer, had a baby this summer, born on August 10th. His name is Alexander and he was 9 lbs. 7 oz. and 21 1/2 in. long. "Except for sleep, we are all doing great. It's our first and I love being a dad," Tibor writes.

Tibor just started his second year at Northwestern University in their Master of Management in Manufacturing program, a joint program with the Kellogg School of Management and the McCormick School of Engineering. Tibor loves it, but is also struggling to figure out what he wants to do when he "grows up." Tibor spent the summer working in Quality Assurance for the U.S. Can Company in Chicago, and will finish his degree in June.

Lola Matysiak, '91, is engaged to **Rob Lohr;** the wedding will be in June 1995, after Lola completes her work at Los Alamos National Laboratories. Lola attended the Alumni/ae Leadership Conference in October, as did Penny Fusco, '90, her office mate at LANL. Lola and Penny founded the MIT Club of New Mexico, and

were both out attending the conference and a training session at Aspen Tech in Cambridge.

Chan Yoo was married to Gia Kim (post-doc MIT) in October. Chan is currently woking on a PhD in NukeE at MIT. In attendance at the wedding were **Melissa Frank, Steve Cheng, Thomas Chang, David Yuen,** Lisa Louie, '90, Chris Hwang, "86, Chih-ming Chiang, '87, and David Redkey, '88. Chan and Gia honeymooned in Mexico.

Well, that's it for this month. Thanks again to everyone who wrote in, and start planning those reunion trips! Please send news and photos!—**Henry Houh,** secretary, 4 Ames St., Cambridge, MA 02142; phone: (617) 225-6680, fax: (617) 253-2673, e-mail: tripleh@mit.edu or henry_houh@mit.edu

The Mastrian/Williamson, '91, wedding—back row, from left: Sue Perrin, '91, Jamie Nagle, '91, Iman Brivanlou, '92, Jeanne Druding, '91, Henry Wong, '92, Adam Braff, '91, Mark Hanson, '88, Emil Dabora, '91, Shawn Mastrian (the groom), '91, Jane Williamson (the bride), '91, Richard Williamson (father of the bride), '57, William Fincke, '51, Reza Jalili, '89, Susanne Perutz, '91, Bill Joseph, '91, Kristine AuYeung, '91, Paul Lefelhocz, '91, Cathy Morrison, '91. Front row, from left: Aric Ledell, '93, Peter Phillíou, '51, Laura Adams, '91, Cary Gumbert, '94, Cynthia Madra, '91.

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Congratulations to **Julif Wissink** and Sayan Chakraborty ('89)! They were married this summer in Belding, Mich. Among the MIT alums attending were **Erica Wickstrom, Lynn Chewning, Laura Fleming, Toby Sanders,** Sam Druker ('89), Mike Berube ('89), Denis Bulsen ('88), Chris Racicot ('88), Scott Lordi ('88), Phil Cohen ('88), Steve (Benny) Stein ('88), Tareq Hoque ('88), and Terry and Cathy (Sybert) Olkin ('88). Word has it that the night before the wedding there was a pig roast at Julie's farm. Everyone had a lot of fun and got to see the baby cows and pigs! . . . **Joon A. Ooi** is getting an MBA at Stanford Business School. . . . **Sandy Serkes** is working on an MBA at Harvard. . . . **Debbie Bein** and **Julie Kim** are both in the master's program at MIT's Sloan School of Management.

Teresa Zimmers is doing research at NIH in addition to serving as the computer guru, office manager, grant writer, and database designer for a nonprofit cancer organization. Teresa is also the executive director for a new science education initiative which is working to create novel hands-on, kit-based teaching modules on everything from electromagnetism to cell biology to astronomy. They are now beginning to test-market the kits and would welcome suggestions and ideas from anyone who is interested in contributing. In between all these commitments, Teresa is working on a PhD at Johns Hopkins in the biochemistry, cellular and molecular biology program—but don't think that Teresa doesn't take time out for fun. She recently took a month off and went to Hawaii, where she learned to boogie board, surf, and play golf. She's also planning to head off to Costa Rica to watch the turtles hatch and enjoy the rain forests before they all disappear.

Jon Woodman graduated from Ohio State University College of Law in May and completed the bar exam for the state of Ohio in July. Upon being licensed, Jon will be opening his own law office and practicing mainly in the area of criminal law. . . . Looks like after **F. Burris Jackes**'s mechanical engineering training at MIT, he has decided to try something totally different—the entertainment industry. Burris was the scenic designer in the recent Chiswick Park Theater production of *Nostalgia: A Musical Revue.* After MIT, Burris went to Northwestern University to study stage design. His other professional credits include *A Broadway Revue* at the Chiswick Park Theatre, and when he's not designing scenery, he is the theater's technical director.

Linda Kah writes that she's been living in Somerville and working for a PhD in geology at Harvard. She's learned that finding both a suitable thesis topic and the rocks to go with it has been quite a challenge. In 1991, Linda spent a few months working in northern Montana but decided to leave that thesis prospect for a more remote field area: Arctic Canada. Linda ended up spending two months in a tent on Northern Baffin Island, where she was 100 miles from the nearest people, enjoyed 24 hours of sunlight, great views of icebergs, and amazing weather. Luckily there were no encounters with polar bears, although if there were, Linda was prepared. She had learned to shoot a 12-gauge shotgun just in case. The only downside was that she had to spend the two months up there with no shower!

Celisa Date was featured in the July 25, 1993, issue of the *San Jose Mercury News.* The article talked about the importance of summer internships for college students. Celisa was an intern for Intel Corp.'s flash memory group in Santa Clara, Calif. She is currently in the doctoral program in solid state physics at Stanford.

Thanks to everyone who wrote in! Keep sending in the news to—**Ning Peng,** secretary, 483 Beacon St., #41, Boston, MA 02115, or ning@athena.mit.edu

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Congratulations to **Jane Williamson** and **Shaw Mastrian,** who were married on August 21! The wedding party included **Kristine Au Yeung, Susanne Perutz, Cathy Morrison, Emil Dabora, Adam Braff,** and **Paul Lefelhocz.** A host of other MIT alums, including friends of her father, '57, attended the wedding (see photo). Jane did her best to gather information about classmates who attended her wedding, but as she was the one getting married, she writes, "I got to talk to people for about one minute each." Jane spent the summer at Hahn Loeser & Parks, a Cleveland law firm, where she "worked with lots of wonderful people and had a very good experience." She sends news that **Cynthia Madras** started graduated work at Tufts in September.

An article in the *St. Louis American* featured Rhodes Scholar **Darcy Prather**'s extraordinary experiences and ambitions. After Prather returned from Oxford last spring, he taught in a summer program for inner city youths in his hometown of St. Louis. Prather began work for a management consulting firm in Chicago in the fall, but told the *American* that he plans to "come back to open my own school."

Please send news of recent travels, projects, or adventures to **Andrew Strehle,** secretary, 566 Commonwealth Ave., #406, Boston, MA 02215, (617) 262-3495

92

Hey everybody, Happy New Year! This month marks three semesters or a year and a half since we've graduated and gone our separate ways. Despite the time and space that has distanced many of us, I am proud to say that our '92 spirit is going strong. The letters keep pouring in with really exciting news about our friends.

Kim A. Heroy and **Greg Rogalski** were married August 1 in an outdoor ceremony in Colorado. Congratulations! If I'd known I could have swung by for a *Tech Review* photo opportunity. **Kathryn Fricks, Karina Ribgy,** and **Laura Walhof** were bridesmaids and **Bensen Wen** was the best man. Kim and Greg spent their honeymoon in Ecquador, and now they're back in Berkeley, Calif. In May, Kim finished a master's degree in environmental engineering at University of California Berkeley and is now working for Radian Corp. Greg works as a software developer for Oracle Corp. **Kathryn Fricks** is working on a master's degree in aero/astro at MIT. **Karina Ribgy,** also in graduate school at MIT, is working toward a PhD in materials science and engineering. **Laura Walhof** is teaching high school chemistry in Chicago. She spent the summer with Kim and Greg in California taking a class for science teachers at Exploratorium, a science museum in San Francisco. **Benson Wen** is working as a programmer in Boston. Kim and Greg also report they've seen quite a bit of **Ken Duda** and Jen Hwang ('91), who were married in May. Ken received a master's degree in Course VI from MIT this past spring and has started working on a PhD at Stanford.

A scary police lineup at best, according to the bride and groom (all suspects not otherwise classed are from '92). From left, standing: Seth Cohen, Adam Riess, Iren Chow, Henry Chung, '93, Dawn Watkins Chow (the bride), who covers the lower half of the face of Marc Wisnudel, '91, John Watkins Chow (the groom), Dan Green, Ellen Shen, '91, Mike Gull, Kate Bergeron, '93, Brian Lu, '91, who is obscuring almost entirely—save for a bit of forehead—Ashley Shih, '91), Enrique Herrera, '91, Sue Katz, Brian Katz, '91, Amelia Lapeña, '94, and Jeff Falkowsky. From left, kneeling: Henry Houh, '89, Albert Cheng, Mohsin Ansari, Mike Rizen, '91, and Theresa Derderian.

And the list keeps going. . . . Congratulations to **Jennifer Hill**, who was married to Rice graduate Brian West in San Marino, Calif., on June 26. The reception was held at the Athenaeum at Cal Tech. Amy Anderson Chang ('91) and her husband Andrew Chang ('88) traveled to California for the wedding. Currently, Jennifer and Brian are living in Austin, Tex., while Jennifer pursues a PhD in biomedical engineering at University of Texas. Jennifer recently patented a photopolymerized hydrogel material used to prevent thrombosis and hyperplasia following balloon angioplasty. Congratulations on the patent, too! I'm happy to spread such exciting news to our peers.

Navy ensign **Robert B. Pember** recently passed the midway point in a six-month deployment aboard the guided missile frigate USS *Hawes*, home-ported in Charleston, S.C., as part of the aircraft carrier USS *Theodore Roosevelt* Battley Group. In August, elements of the battle group were in the Red Sea, where they were enforcing the U.N.-imposed "no-fly" zone over southern Iraq. USS *Hawes*, Standing Naval Force Mediterranean, is working with NATO allies to enforce the U.N.-imposed "no-fly" zone over Boznia-Herzegovina. While on station in the Adriatic Sea, the 445-foot-long Oliver Hazard Perry-class frigate participated in Operation Provide Promise, which provides relief supplies to wartorn former Yugoslavia and performed a medical evacuation of two Italian fisherman whose ship was fired upon by the Serbo-Mongtenegro Navy when it sailed into Montenegro's coastal waters. Be well, Ben, and be careful.

Ramon Cajina wrote from Prague in August telling me that he just finished getting a graduate degree in fluid mechanics in Belgium. After graduating, he interrailed around Europe—visiting Prague, Poland, Hungary, Austria, Switzerland, Italy, and Greece. Malee Lucas ('93) did some traveling with him. Ramon writes that he attended **Melanie Lazaro** and **Trinidad Flores**'s wedding in Florida in July. Congratulations to Melanie and Trinidad. . . . **Joanne Gutierrez** also send word about Melanie and Trinidad, as well as filling me in on her life. Joanne finished a master's degree in Course VI at MIT last spring and has moved to Phoenix to work in the rotational program for Motorola's Semiconductor Products Sector. During her first three months, she chose to work on zener diode development (zener diodes are special diodes that also operate in the reverse breakdown). Thanks for the explanation, but I still don't get it. The weather in Phoenix was mostly in the 100s over the summer, reports Joanne. She says that the Valley of the Sun (Phoenix is surrounded by mountains) is beautiful and offers plenty of great terrain and breathtaking views for hiking and camping. Lately, Joanne has seen a bunch of MIT alums including **Kiet Van, Paul Duran, Pablo Rodriguez, Kathy Nelson**, and **Evaristo Gonzales**, who is working for Ford.

Alexandre Witze spent last academic year at UC/Santa Cruz in a graduate program for science journalism, directing herself away from geology and all the research that goes with it. After UCSC, Alex started doing a required internship, writing for the weekly science section of the *Dallas Morning News*. When she has completed her internship, Alex hopes to contribute to national magazines and newspapers as a freelance writer. She will be based in south Lake Tahoe, Calif., and may be looking for skiing lessons. Alex has also ventured to the land down under a few times this year as her parents have moved from New Jersey to Sydney, Australia. Alex mentions that **Debbie Wells** was working at the seismological laboratory at Caltech and last she heard, Debbie was thinking about going back to grad school this past fall.

Emilio Mayorga went back to Nicaragua after graduation from MIT to see his folks and to look for an environmental job, but the economy there is quite devastated, making it difficult to find work. After nine months he returned to the States "to the safety and warmth of graduate school." Emilio is in Seattle at University of Washington's School of Oceanography. He says that his research will actually deal with the Amazon, and next summer he may go to Brazil to start doing field research. In Nicaragua, Emilio became an educational counselor (EC) and is planning to continue with it in Seattle. He has heard from another EC enthusiast, **Glorybell Silhy**, who went back to El Salvador after graduation and was recently married.

Jonah Benton moved back to New York City this summer after working in Hartford, Conn., for eight months at Travelers Insurance. Jonah is consulting and writing software with a friend of his. He is working long hours but still finds time to go to Fairway Market on 74th and Broadway. Fairway Market, Jonah describes, is "reason enough to move to New York: mushrooms alone occupy nine square feet. Their fruit is wonderful and they have the best bagels in the city. I love food and cooking and Fairway is about the closest to an ideal supermarket that I've ever seen. When I get to heaven I want to be able to shop there, only without the crowds. Great place."

Don't fret classmates. The class gift—the Program for the Encouragement of Technology (PET)—is still under way. There will be a workshop at MIT in January 1994. It will be the first time that our program is being implemented. Junior high school students from the Cambridge/Boston area will be participating. If you would like to get involved, please call me @ (303) 920-7769 or try Maryglenn Vincens in the Alumni/ae Association office (617) 253-5489. Sorry for the short notice, but get in touch with us ASAP. Also, don't forget to send in your pledges. Thanks so much.

I'm still in Aspen, so keep writing.—**Leslie Barnett**, secretary, P.O. Box 7604, Aspen, CO 81612-7604, (303) 920-7769 (home), (303) 925-1961 (work)

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Please send news for this column to: **Mari Madsen**, secretary, 12-16 Ellery St. #405, Cambridge, MA 02138

PUZZLE CORNER

Continued from Page MIT 50

Other Responders

Responses have also been received from S. Altchuler, L. Antinarelli, M. Archambault, S. Balbus, J. Banerjee, R. Banerjee, L. Beckett, B. Benulis, L. Bernacki, S. Booker, S. Boylan, F. Carbin, E. Chaglassian, C. Coltharp, N. Cosman, C. Counselman, S. Cram, C. Dale, K. Doniger, M. Driscoll, P. Duffy, A. Egler, A. Elsworth, A. Eurdolian, S. Feldman, A. Flemming, M. Foley, M. Fountain, J. Friedman, L. Gowan, M. Hailperin, W. Hartford, W. Hartford, R. Hedrick, R. Hess, D. Hopkins, J. Keilin, J. Kelleher, C. Kelly, R. King, N. Ko, T. Lawsonk, H. Ma, C. Meissner, A. Ornstein, B. Parry, R. Pena, N. Petite, J. Prussing, H. Reynolds, K. Rosato, J. Rudy, M. Samuelson, J. Solman, K. Thorpe, A. Tracht, N. Ulman, L. Vogel,

Proposer's Solution to Speed Problem

It has a pole at the equator.

COURSE NEWS

I CIVIL AND ENVIRONMENTAL ENGINEERING

Antonio A. Gonzalez Queredo, SM '77, writes: "I was promoted to associate professor in the Department of Civil Engineering at the University of Puerto Rico at Mayagüez. I am presently acting director for the Civil Infrastructure Research Center. In August 1991, I received a PhD from Purdue University in the area of construction engineering and management. I enjoy academic life a lot." . . . **James V. Hamel**, SM '66, of Hamel Geotechnical Consultants in Monroeville, Pa., sends word: "I recently returned from Guinea, West Africa, where I conducted preliminary investigation for a gold mining project. Domestically, I remain busy with dam, infrastructure, and environmental projects." . . . From Chatham, N.J., **Robert Harvey**, SM '80, sends word: "After leaving Exxon in 1984, I have been at the Port Authority of New York and New Jersey at various levels of responsibility. I currently am manager of the Office of Capital Programs/Value Management in the office of the executive director, where I monitor progress on the capital program. My most recent accomplishment involved the establishment and management of the Project Central Team to recover the World Trade Center from the February 1993 terrorist bombing. Also the development and direction of a value management program that used outside experts to analyze the functions, improve, and reduce the cost of over $2 billion worth of projects over the last two years.

Norman W. Llewellyn, SM '49, writes from Farmington, Conn.: "I have a very satisfying retirement activity of building homes for the homeless with Habitat for Humanity in Connecticut and South Carolina." . . . From Boca Raton, Fla., **Edward C. West**, SM '56, reports: "Since Hurricane Andrew, I've been working with the Enterprise Foundation planning the rebuilding of Homestead, Fla. Our plan is approved and we are now facilitating implementation." . . . **Lawrence A. Ludwig**, SM '32, writes from East Stroudsburg, Pa.: "I am still keeping busy as treasurer of eight local organizations: Pocono Family YMCA, Historical Farm Association, Beaver Valley Preservation Trust, Monroe County Historical Association, Neighbors of Monroe County, League of Women Voters of Monroe County, Stroudsburg Area Torch Club, and the Kettle Creek Environmental Fund." . . . Word from **Stephen Gordon**, SM '82, of Oakland, Calif.: "My wife, Tracy, and I are celebrating the arrival of our first child, Evan Bryce, born August 22, 1993. I will soon be joining the firm of Environmental Science Associates, Inc., in San Francisco, as director of transportation projects." . . . **Brian J. Watt**, ScD '70, has resigned as president of the Environmental Group at Joy Technologies, Inc., in Houston. . . . **Paul P. Mathisen**, SM '89, PhD '93, and **Roberto Pietroforte**, SM '87 (IV), SM '87, PhD '92, have both been appointed assistant professors of civil engineering at Worcester Polytechnic Institute in Worcester, Mass. . . . **Robert W. Clark**, SM '63, has joined Adirondack Community College in Queensbury, N.Y., as assistant professor of engineering.

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II MECHANICAL ENGINEERING

From Boston, **K. Paul Tyra**, SM '82, SM '93 (XV), writes: "1993 has been a busy year. I left Digital Equipment Corp. and my position as an engineering manager in September to join a start-up company in the Boston area that is focusing product-development efforts at the capital equipment markets. I will be involved with strategic business and technology efforts in this new venture. I completed a second master's at MIT in the Sloan Management of Technology program, graduating in June 1993. My wife, Wendy, and I have a 21-month-old daughter (Elizabeth) and are expecting another child in May 1994. My daughter joined me on the podium as I received the master's last June. Her pink dress was quite a contrast to the sea of black robes." . . . **Tomas B. Ubach**, SM '81, writes from Sidney, Ohio: "I am manager of tool development at Copeland Corp., manufacturer of compressors for HVAC." . . . **Fred Landis**, SM '49, ScD '50, has retired as professor of mechanical engineering at the University of Wisconisin at Milwaukee as of this January. . . . **Lawrence S. Daniels**, SM '66, (XV), SM '66, has been named VP for strategic planning at Biogen, Inc. Prior to this he was VP for marketing and business development at the Cambridge-based company. . . . **Mauricio Bazan**, '50 (IX), SM '69, has been named a Fellow of ASME. Bazan is currently working in Caracas, Venezuela, as an engineer.

Donald M. Reynerson, NA '75 (XIII), SM '75, has joined Construction Systems Associates, Inc., as VP and director of nuclear projects. CSA, headquartered in Marietta, Ga., is an engineering and software services company that specializes in the development and implementation of three-dimensional database configuration management models in order to improve the efficiency and quality of the management of large facilities. Reynerson is responsible for nuclear program business development and project implementation. He was previously with the Institute of Nuclear Power Operations (INPO), and was responsible for management reviews of American commercial nuclear power operating plants. He was also responsible for INPO engineering and construction programs in support of the Advanced Light Water Reactor program. Reynerson was the completing construction director at the Comanche Peak Stream Electric Station, and the director of Nuclear Plant Engineering at the River Bend Nuclear Station. He also served as project manager at Lawrence Livermore National Laboratory, and as an engineering day officer in the U.S. Navy nuclear submarine programs. . . . Navy Commander **Gregory Vaughn**, SM '88, OCE '88 (XIII), has assumed command aboard the submarine USS *New York City*, homeported in Pearl Harbor, Hawaii.

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III MATERIALS SCIENCE AND ENGINEERING

Alan W. Postlethwaite, SM '49, writes: "After 30 years in semiconductor and electronic component R&D, I moved to the Smithsonian Institution's Conservation Analytical Laboratory as deputy director. The lab carries out R&D on the conservation and technical examination of objects of artistic and historical interest. I will be retiring at the end of the year and spending time between D.C. and Massachusetts, where I have three daughters and six grandchildren. Other MIT people in the lab are **Pam Vandiver**, SM '83, PhD '85, and Martha Goodway, '58 (IX)." . . . **Chrysanthe D. Terwilliger**, PhD '93, has been named assistant professor of mechanical engineering at Worcester Polytechnic Institute.

Charles O. Smith, SM '47 (II), ScD '51, retired professor of engineering at Rose-Hulman Institute of Technology in Terre Haute,

DEGREE CODES

AE	Aeronautical Engineer
BE	Building Engineer
CE	Civil Engineer
CHE	Chemical Engineer
CSE	Computer Science Engineer
DPH	Doctor of Public Health
EAA	Aeronautical & Astronautical Engineer
EE	Electrical Engineer
EGD	Doctor of Engineering
ENE	Environmental Engineer
MAA	Master in Architecture Advanced Studies
MAE	Materials Engineer
MAR	Master in Architecture
MCP	Master in City Planning
ME	Mechanical Engineer
MET	Meteorologist
MIE	Mineral Engineer
MME	Marine Mechanical Engineer
MNG	Master in Engineering
MPH	Master in Public Health
MTE	Metallurgical Engineer
NA	Naval Architect
NE	Naval Engineer
NUE	Nuclear Engineer
OCE	Ocean Engineer
PhD	Doctor in Philosophy
ScD	Doctor of Science
SE	Sanitary Engineer
SM	Master of Science

Ind., has received the Machine Design Award of the ASME. The award, established in 1958, recognizes achievement in the field of machine design. Smith was cited for his "distinguished teaching of engineering design; for long-term national and international promotion of improvements in design practice and more effective methods for teaching design through extensive publications, presentations, workshops, and professional society activities." Smith has had a full career, teaching at WPI and then at MIT before going to Alcoa Laboratories and then E.I. duPont De Nemours and Co. He spent 10 years with Oak Ridge National Laboratory and later taught at the University of Detroit in Michigan, the University of Nebraska at Lincoln, and Rose-Hulman. Since his retirement in 1986, Smith has consulted and taught short courses and spent the 1987–88 academic year as a visiting professor at the University of Limerick in Ireland. During his service in WWII, Smith designed the life jacket light adopted by the Navy, Coast Guard, and Merchant Marine.

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IV ARCHITECTURE

Donna P. Duerk, MAA '80, writes from San Luis Obispo: "I still love California and teaching at Cal Poly. Van Nostrand published my first book in September: *Architectural Programming: Information Management for Design*." . . . From Amesbury, Mass., **Catherine Kivian**, SM '89, reports: "I returned to the Boston area to open a consulting company called The Renaissance Advisory Group, specializing in the real estate and hospitality industries. I enjoyed seeing so many fellow alums at the boat-ride/clambake on Boston Harbor and look forward to doing it again." . . . **J. Christopher Kirk**, SM '87, sends word from Seattle, Wash.: "I am VP of Dingfield Associates, Ltd., a real estate, planning, project management, and development company. I am also commissioner of the King County Landmarks Commission and a member of the American Institute of Architects."

Larry Vale, SM '88, writes: "My wife, Julie Dobrow, and I announce the birth of our second child, Aaron Dobrow Vale on August 19, 1993. He joins sister Mira, 2 1/2. I have recently been awarded the Mitsui Career Development Chair at MIT, and am an assistant professor in the Department of Urban Studies and Planning. Julie is an assistant professor and director of graduate programs at Boston University's College of Communication."

Peter van Dijk, MAR '56, was recently profiled in the Cleveland *Plain Dealer Sunday Magazine*. The article highlights van Dijk's upbringing in the tropics, which included graduation from high school at 15 and entry into a Cornell University engineering program at 16. Two years later he was at the University of Oregon, which was followed by a stint in the Korean War. Next came MIT and then a Fulbright scholarship spent in Rome. Much of van Dijk's professional career has been spent in Ohio where his firm, van Dijk, Pace, Westlake and Partners, the oldest continuing architectural firm in Northeast Ohio, has designed the Blossom Music Center, E.J. Thomas Performing Arts Hall in Akron, and Ursuline College in Pepper Pike.

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V CHEMISTRY

From Topsfield, Mass., **Alan E. Walts**, PhD '85, writes: "I recently completed the 65th Program for Management Development (PMD) at Harvard Business School. Following this three-month program I assumed the position of VP and general manager of Genzyme's Pharmaceutical and Fine Chemical Division. I have been employed by Genzyme since 1986 and most recently held the position of VP of R&D." . . . **Keith J. Stine**, PhD '88, reports: "I have been an assistant professor of physical chemistry at University of Missouri/St. Louis since 1990, and I have been establishing a research program in surface chemistry." . . . Word from **Richard A. Day**, PhD '58, in Cleves, Ohio: "I am professor of chemistry and biological chemistry at the University of Cincinnati. Most recent research stems from discovery of C_2N_2 as a protein salt-bridge specific reagent. Also in last few years in b-Lactam work have shown many disasteromers of native b-Lactam to be antibiotics with effectiveness against bacteria resistant to newer generation *b*-Lactams. The diastereomers are made by a four-step total chemical synthesis." . . . From Arlington, Va., **Peter J. Denning**, SM '65, PhD '68, reports: "I have formed the Center for the New Engineer in the School of Information Technology and Engineering at George Mason University in Fairfax, Va. This center is dedicated to developing new approaches to engineering education that connect research to curriculum and university to K–12 regional schools. Contracts from ARPA and NSF have been awarded to support this work. I am associate dean for computing and chair of the Computer Science Department." . . .

Charles Christy

Charles A. (Tony) Christy, PhD '65, has been named VP for product development at Programart Corp. in Cambridge. "He brings to this R&D post broad technical and managerial experience, as well as an extensive background in the design, development, and implementation of large commercial applications incorporating leading-edge technologies," states a company press release. Christy was with Arthur D. Little for 18 years, where he was VP of ADL Systems, leading its thrift banking system division. He was also founder of ADL's Technology Acceleration Center, which performs R&D in the areas of artificial intelligence, network computing, client/server development, and object-oriented programming.

James Beatty

James W. Beatty, PhD '60, professor of chemistry at Ripon College in Ripon, Wisc., has been appointed to the Accreditation Review Council of the Commission on Institutions of Higher Education (CIHE) of the North Central Association of Colleges and Schools (NCA). Founded in 1985, the NCA is a voluntary membership organization of elementary, secondary, and postsecondary institutions. Its purpose is to improve

education through evalution and accreditation. Beatty has participated in the work of CIHE since being selected for its Consultant-Evaluator Corps in 1972, when he served on evaluation teams to 27 institutions. Beatty will participate as a reader and will serve on review committees in the CIHE's review procedures that follow on-site visits to schools and colleges.

Charles Lermond, SM '53, was recently profiled in Cleveland's *Plain Dealer*. Lermond, a weaver, moved to Oberlin, Ohio, in 1974 for a market research job and was layed off a few years later. It was at this point that he grew weary of "this industry garbage" and undertook a career change. The article states: "The man who couldn't tie a square knot when he started weaving nearly 40 years ago, has taught himself through books and practice." An IBM computer upon which he creates designs sits beside the looms in his store, the Loom Shed. He saves time and yarn by experimenting with colors and designs on the computer before going to the loom. "He has translated a 1928 book of designs, considered to be the bible of weaving, into a computer version." Lermond, who edits a worldwide newsletter called *Computers in Weaving*, works more hours now than when he was in corporate America, and the money is not as good. But [he] enjoys his work. 'There's more satisfaction than paychecks,' Lermond said." . . .

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VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

From Sun City, Ariz., **Dale Pollack,** ScD '40, sends word: "My wife has been urging me to retire for many years, and I've been telling her for each of the last five years, 'one year more.' I finally reached the end of her patience and I resigned from the post I enjoyed as a professor of EE at Tuskegee University. I am now completing some texts I've been working on, and doing some consulting work on my specialties, communication and avionics." . . . **Don Ferguson,** '57, writes from Williamsville, N.Y.: "I have retired as a project manager at Ferguson Electric Construction Co., Inc., a contractor serving five counties of Western N.Y. State. I will continue serving on the MIT Education Council, being a deacon in Worldwide Church of God, teaching stagelighting in a high school, and beoming more active in the Rotary Club." . . . **David F. Winter,** SM '48, reports from Kirkwood, Mo.: "I am active in consulting with public utilities and dairy operators to measure and mitigate neutral to earth voltage which gives rise to cow contact voltage. At low levels this voltage and current produces marked behavior and health problems to cows. I attempt to research and relieve this situation." . . . **Robert C. Gesteland,** SM '57, PhD '61 (VII), writes: "I hold two positions: VP for research and university dean of advanced studies at the University of Cincinnati and professor of anatomy and cell biology at University of Cincinnati Medical Center. My research laboratory studies the biophysical basis for the sense of smell, carrying on the tradition of sensory neuroscience begun by my MIT mentor Jerome Lettvin, '47, (XVIII)." . . . **David L. Waltz,** '65, SM '68, EE '68, PhD '72, has been appointed VP of the Computer Science Research Division at NEC Research Institute, Inc., in Princeton, N.J. For the last nine years, Waltz has been at Thinking Machines Corp. in Cambridge, most recently as director of advanced information systems. At the same time, he was professor of computer science at Brandeis University.

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VI-A INTERNSHIP PROGRAM

In the November/December column I mentioned the September 1, 1993 retirement of Director **Kevin J. O'Toole,** SM '57, NE '57 (XIII). I am happy now to announce the interim management of the VI-A Internship Program, which will function until a new director is appointed. **J. Francis Reintjes,** professor emeritus and senior lecturer, will serve as acting director. I, as VI-A director emeritus and lecturer, will act as consultant and assistant. Professor Reintjes was director of the program from Spring 1960 through Spring 1969, following which I assumed the directorship continuing through June 1987. Quoting from a memo by Department Head **Paul Penfield,** ScD '60, "In this pair of people we have a wealth of experience to draw on. The very able support staff, Lydia Wereminski and Lucy Allen, will continue to work for the Program, Lydia for the VI-A Office and Lucy from her new position in the Undergraduate Office."

This is also a year of major transition for Course VI, which has inaugurated a five-year professional Master of Engineering (MNG) degree program for the majority of its students. The feeling is that our students need additional education to be professionally trained. The success of the five-year VI-A Program, with its simultaneous award of the SB and SM degrees, serves as a basis for this new Course VI Professional Degree Program. The VI-A Program itself is incorporated as an integral part of this plan and its graduates will simultaneously receive the SB and MNG degrees.

Looking ahead, VI-A plans to add two new companies to its roster this coming spring: Bankers Trust Co. of New York City and Qualcomm, Inc., of San Diego, Calif. A founder of Qualcomm is **Andrew J. Viterbi,** '56, SM '57, who also serves on this department's visiting committee. . . . **Cecil H. Green,** '23, SM '24, was on campus in October for the meeting of the MIT Corporation and the annual Cecil & Ida Green Fellowship Luncheon. He and I attended the memorial service in the MIT Chapel for our friend, **Robert R. Shrock,** who passed away in June. One of Professor Shrock's last undertakings was writing the biography *Cecil and Ida Green—Philanthropists Extraordinary.*" This past summer Cecil continued to host his annual TI VI-A Luncheon in Dallas at which he was honored on his 93rd birthday!

Two items of interest gleaned from the IEEE Boston Section's publication *The Reflector*: **Irwin Dorros,** '56, SM '56, executive VP and member of the board of directors at Bellcore, was the lead presenter at an IEEE video conference,-"2020 Vision: The Information Era," for the Merrimack Valley Subsection; and **Carey M. Rappaport,** '80 (XVIII), '82, SM '82, EE '82, PhD '87, of Northeastern University addressed a meeting of the Antennas & Propagation Chapter on "Treating Heart Disease with A Millimeter-Wave Angioplasty Balloon Angioplasty Antenna."

A surprise visitor to the VI-A office was **Daniel M. Naor,** '80, SM '81, a former advisee of mine, who is headquartered in Paris with McKinsey & Co. following his earning an MBA from INSEAD in France. His brother, **Michael Naor,** '83 (XV), '83, resides in Israel and has his own consulting company.

A nice note from **Michael A. Isnardi,** '82, SM '83, PhD '86, a manager with the David Sarnoff

Research Center in Princeton, N.J., tells of his becoming a father of twin girls in August 1993, and that he expects to see us in February when on campus for VI-A recruiting. . . . Other contacts, since last writing, have included **Richard S. Grinnell**, '93, SM '93, who's with PictureTel of Danvers, Mass.; and **John V. Wolfe**, '85, SM '88, who has been working with our computer science staff at Tech Square in Cambridge.—John A. Tucker, director (emeritus), VI-A Internship Program, MIT, Room 38-473, Cambridge, MA 02139-4307.

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VII BIOLOGY

Robert C. Gesteland, SM '57 (VI), PhD '61, writes: "I hold two positions: VP for research and university dean of advanced studies at the University of Cincinnati and professor of anatomy and cell biology at University of Cincinnati Medical Center. My research laboratory studies the biophysical basis for the sense of smell, carrying on the tradition of sensory neuroscience begun by my MIT mentor J.Y. Lettvin, '47, (XVIII)." . . . Illinois Institute of Technology (IIT) Associate Professor of History **Thomas J. Misa**, '81, was the recipient of that university's 1993 Bauer Family Excellence in Undergraduate Teaching Award. Misa, who has taught history for over 10 years, joined ITT in 1987. Students selected Misa for the teaching award, which includes $1,500 and a plaque. . . . **Robert Weinberg**, '64, PhD '69, Course VII professor and a member of the Whitehead Institute for Biomedical Research, has received a one-year, $105,000 grant from the American Cancer Society for his research on the retinoblastoma protein and its role in transforming normal cells into cancer cells. Retinoblastoma is a type of eye cancer that develops in young children. Weinberg was among the first to show that oncogenes, the cancer-causing genes now linked to a wide variety of human tumors, are altered versions of normal cellular genes. More recently, his laboratory played a central role in the isolation of the first known cell growth-suppressor gene, Rb, the retinoblastoma gene. Hi new research will explore interactions between the Rb and protein and cyclin proteins, vital components of the cell cycle clock. Weinberg has been an American Cancer Society Research Professor at MIT since 1985.

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VIII PHYSICS

Tsur Bernstein, PhD '71, writes: "10 years ago we came back to the States after 11 years in Israel. I am now working for GE Medical Systems as manager of advanced applications in magnetic resonance imaging (MR). It is fun, after working in micro-electronics, ion-implantation, and nuclear medicine detectors—to come back to my PhD 'roots' of high magnetic fields, Fourier transforms, and magnetic materials. Surprise—it has actually turned out to be useful! It is also fun, exactly 25 years after we landed in Cambridge, to have our oldest son, Noam, start a PhD program in physics at that other school on Mass. Ave. With my wife, Zmira Bernstein, PhD '71 (V), who has shifted to computers, and two other kids in high school, we are now living near Milkwaukee, Wisc." . . . **Frank von Hippel**, '59, professor of public and international affairs at the Woodrow Wilson School at Princeton University in Princeton, N.J., has been named a 1993 MacArthur Fellow. Von Hippel specializes in both the policy and technical aspects of nuclear weapons. In collaboration with scientists from the former Soviet Union, he recently worked to lay the technical groundwork for disarmament and plutonium disposal. Von Hippel, who frequently testifies before Congress, has worked in recent years on a strengthened non-proliferation regime, a nuclear test ban, and verified warhead elimination. He has also made significant contributions to improvements in automobile efficiency. . . . **James C. Licini**, PhD '87, has been promoted with tenure to associate professor of physics at Lehigh University in Bethlehem, Pa. Licini is a specialist in experimental solid-state physics and semiconductor devices. He joined the faculty in 1987 as an assistant professor. Prior to that, he conducted research at MIT, AT&T Bell Laboratories, and IBM. His current research is being funded by the NSF, Bell Labs, and GE Corporate R&D. . . . **Bennet J. Brown**, '91, has been named one of 100 teachers nationwide to receive the 1992–93 Sallie Mae First-Year Teacher Award. This award recognizes outstanding performance by new elementary and secondary school teachers. Brown's high school teacher, James Jefson of Des Moines, Iowa, received a Sallie Mae Teacher Tribute award which honors the teachers who most influenced the winning first-year teachers' decision to pursue a career in education. The awards program, now in its ninth year, is sponsored by Sallie Mae, a corporation that specializes in financing student loans and other education-related services. Brown, an eleventh- and twelfth-grade physics and chemistry teacher at Du Sable High School in Chicago, also received $1,000.

Elsa Garmire

Elsa M. Garmire, PhD '65, has been named the William M. Hogue Professor in Electrical Engineering at the University of Southern California's School of Engineering. Garmire, a pioneer in studies of nonlinear optics, integrated optics, and optical bistability, is called the "First Lady of Lasers," both in tribute to her early participation in the field of laser physics and in recognition of her continuing preeminence in the field. She was, in fact, the only woman in the first generation of laser researchers. This year, Garmire began a five-year term as president of the 11,000-member Optical Society of America—only the second woman to hold that office in the society's 76-year history. Garmire, director of the USC Center for Laser Studies since 1984 and professor of electrical engineering/electrophysics at the USC School of Engineering since 1981, is one of the fewer than two dozen women in the National Academy of Engineering, which has more than 1,500 members. She is also a fellow of the Institute of Electrical and Electronics Engineers and a member of the American Physical Society, the Society of Women Engineers, and American Women in Science. Her research interests include optical bistability, signal processing, and computing; nonlinear optics in semiconductors, integrated optics; semiconductor lasers in external cavi-

ties; new diesgns for emiconductor lasers, integrated optics sensors; high power waveguides for infrared and UV application; and fiber optics. Her latest research focuses on applications of lasers and optics in the everyday world. This includes putting optics on a circuit chip—micro-miniature lasers "the size of a grain of salt"—and developing new devices and materials to make better all-optical switches. . . . **Ronnie D. Lipschutz**, SM '78, and Ken Conca are the editors of *The State and Social Power in Global Environmental Politics* (Columbia University Press, 1993). The book is a "collection of original essays that examine the ways in which the complex nature of global and local social, political, and economic relations complicate efforts to address global environmental change," states the book jacket. Lipschutz is assistant professor of politics at the University of California at Santa Cruz, and a senior associate of the Pacific Institute for Studies in Development, Environment, and Security in Oakland. He is the author of *When Nations Clash: Raw Materials, Ideology, and Foreign Policy* and *Radioactive Waste: Politics, Technology, and Risk*. . . . Another new book is *Fear of Physics: A Guide for the Perplexed* (Basic Books, 1993), by **Lawrence M. Krauss**, PhD '88. The book "nimbly ranges over the tools and thought behind the world of modern physics, taking the mystery out of what is essentially a very human intellectual endeavor," says the book jacket. "The book proves that physics can be accessible, exciting, and enjoyable even to those who shamefully wear the scarlet letters SI (scientifically illiterate). The key to understanding, according to Krauss, is not to learn more names and facts but to learn how physicists think." Krauss is the Ambrose Swasey Professor of Physics and Astronomy and chair of the Physics Department at Case Western Reserve University. Krauss, who writes, teaches, and lectures extensively, is the author of *The Fifth Essence: The Search for Dark Matter in the Universe*.

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X CHEMICAL ENGINEERING

Kimberly Ritrievi, SM '85 (XV), ScD '85, sends word: "I am now a senior VP at Lehman Brothers in New York. I've been on equity research analyst for the past six years—the industries I follow are speciality chemicals and photography. In my limited spare time, I enjoy New York immensely and spend as much time skiing in Utah and Colorado as possible." . . . **Howard S. Bryant**, SM '52, ScD '56, writes: "I retired as corporate VP for engineering at the Witco Corp. in Woodcliff Lake, N.J., in July 1993, and moved to Alpharetta, Ga. In September, I also retired from the executive board of the engineering construction contracting division of the American Institute of Chemical Engineers." . . . **Deborah Savage**, PhD '92, reports: "I am currently working for Tellus Institute, a non-profit environmental research and consulting firm in Boston." . . . **Manfred Gans**, SM '51, president of Technology Evaluation & Development Associates, Inc., of Hoboken, N.J., has been named recipient of the Award in Chemical Engineering Practice given by the American Institute of Chemical Engineers. According to an AIChE press release, Gans is "an expert in process development, including synthetic fibers processes, plant start-up, and coal gasification. His work includes hazards analysis, technology assessment, plant troubleshooting, process engineering, pollution abatement, and serving as an expert witness. He has systemized the field of plant start-up, including starting seven first-of-their-kind chemical plants. An AIChE Fellow, Gans has served as a lecturer for the AIChE Today series of continuing education courses on plant start-up, and has also served on the group's national speaker bureau. Gans has been a consultant to the United Nations since 1978. His accomplishements include setting up applied R&D institutes for the chemical and refinery business in developing countries. Presented annually to recognize 'outstanding contributions by a chemical engineer in the industrial practice of the profession,' the award is underwritten by Bechtel National, Inc., and consists of a plaque, a $4,000 honorarium and a $500 travel allowance." . . .**Kevin G. Joback**, SM '85, PhD '89, is the founder of Molecular Knowledge Systems in Nashua, N.H. The company provides consulting services and computer software to the chemical industry to assist in the discovery of high-performance, environmentally compatible chemical products. It has two main software products: Synapse and Cortex. Synapse is a complex chemical data base that is capable of designing new molecules possessing specific physical properties. For example, it can suggest chemicals that replace other ones that are environmentally unsafe, or have higher performance capabilities. Cortex is a software that provides estimates of physical properties of chemicals that can optimize chemical plant performance or can reduce cost by eliminating unnecessary R&D experimentation.

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X-A PRACTICE SCHOOL

The Alumni/ae Association broke new ground last October 2 by awarding its coveted Presidential Citation to an unorganized—but by no means *dis*organized—group of graduates of the Koch School of Chemical Engineering Practice. Thirty-four alumni, most of them in the Practice School in 1935-36, have received certificates honoring them as "dedicated volunteers" who "raised significant fellowship money" during SCEP's endowment drive of the late 1980s. Presidential Citations are given with approval of the Association's Board of Directors for "distinguished service to the Institute or the Association"; they're the highest honor that can go to an alumni/ae organization, and never before has a citation been awarded to an informal group like this one. Acting for the group, of which he has been a major protagonist for 57 years, **William C. Rousseau**, SM '36, who's now visiting lecturer in the department in Cambridge for six months of the year, received the award during the annual Alumni/ae Leadership Conference (*see photo of alumni/ae accepting Presidential Citations on page MIT 7*).

In addition to Rousseau, certificates have gone to **George A. Akin,**, ScD '35, the late **Willard F. Bixby**, '35, SM '36, **C. Wheeler Coberly**, SM '36, **Arthur L Conn**, '34, SM '35, **Arthur H. Crowley**, '35, SM '36, **George H. Cummings**, SM '36, **Thonet C. Dauphine**, '35, ScD '39, **John J. Demo**, '35, SM '36, **John E. Eberhardt**, ScD '36, **Reid Ewing**, '35, SM '36, **Robert C. Gunness**, SM '34, ScD '36, **Auguste C. Hershey**, SM '36, **John H. Howell**, '35, SM '36, **Naci F. Kubicek**, SM '35, **Walter F. Lenoir**, SM '36, **Fred W. Meyer**, SM '36, **Edward W. S. Nicholson**, SM '36, **Henry J. Ogorzaly**, '35, SM '36, **F. Philips Pike**, SM '36, **George C. Putnam**, SM '36, **Walter F. Read,**, '34, SM '36, **John B. Roberts**, SM '36, **Norman T. Robey**, SM '36, **Norris E. Ruckman**, '35, SM '36, **Benjamin F. Schlimme**, SM '35, **James Seth**, SM '36, **Charles W. Smith**, '35, SM '36, **William B. Stevenson**, '35, **Tzeng J. Suen**, SM '35, ScD '37, **Warren E. Sundstrom**, '35, SM '36, **Walter F. Ullrich**, SM '28, ScD '36, **Roy P. Whitney**, '35, '36, and **W. Kelly Woods**, SM '36, ScD '40.

All these men worked at two famous stations of the Practice School—Bangor, Maine (Eastern Corp.—paper) and Buffalo, N.Y. (Bethlehem Steel Co.). Both were notorious for the large scale of the operations in which students participated and, consequently, for the students' extraordinary educational opportunities. Many—presumably including most of the above—will say that those were the glory days of SCEP, responsible more than others for the *esprit* that sets SCEP alumni/ae apart. That may be true, but this group had at least one other factor going for it: a major assist from Rousseau, who has been soliciting news and circulating an annual newsletter ever since 1936.

Dawn Orton, SM '87, PhD '93, was married to **Mark Applegate**, PhD '92, in Phoenix on October 2, and they are now living in San Diego. Orton is with Advanced Tissue Sciences, La Jolla; Applegate with Kelco, San Diego. . . . Lieutenant **Athena Cozakos**, '89, SM '89, stopped at the SCEP office during a Cambridge visit; she is group leader in the Public Works Center, Navy Civil Engineer Corps, Pensacola.

From Minneapolis, **Arthur E. Higinbotham**, SM '60, reports that he is group VP for tape at 3M Co. Two daughters: Kitty, a senior at Wellesley, and Carrie, in her first year at Carleton.

This will reach you just in time for season's greetings, which it brings from those at SCEP and at the *Review*. If you're looking for a new year's resolution that's easy to keep, here's a suggestion: write a few sentences of your latest news and views to the undersigned, so we can share yours with others.—John Mattill, *Technology Review*, W59-200, MIT, Cambridge, MA 02139.

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XI URBAN STUDIES AND PLANNING

From Bethlehem, Pa., **Irwin J. Kugelman**, SM '60, ScD '63, writes: "I will step down as Civil Engineering Department chair at Lehigh University in June 1994 after nine years in office. In July 1994 I will become the holder of the first Browne Chair in Environmental Engineering at Washington University in St. Louis." . . . **Richard P. Fishman**, '77, has been named president and COO at Thinking Machines Corp. in Cambridge. He was a senior partner and managing partner at Milbank, Tweed, Hadley & MCloy's Washington, D.C. office.

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XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

Louis C. Raymond, SM '32, sends word from Chappaqua, N.Y.: "At the age of 67 I went back to college and took up archaeology. For the past 15 years, I have been busy on the most important historical archeological site in the United States, known as the Requa Dig. It covers all the cultural periods of our country from 1720 through 1958. We recovered over 80,000 artifacts that are now stored in a working laboratory museum located in Tarrytown, N.Y. I have also written a book entitled

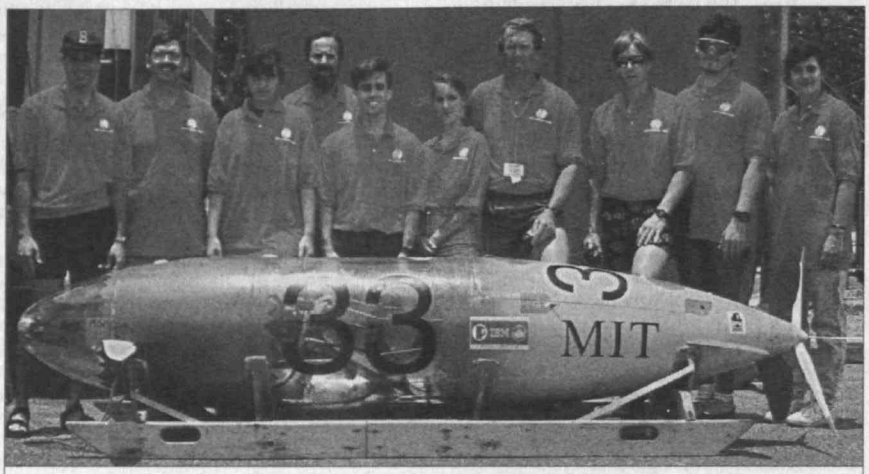
Taking the *Beaver* to Sea

MIT's *Sea Beaver II* boasted a 10-person team of engineers/scuba divers that included one of the most powerful propulsors on the "circuit"—Hauke Kite-Powell, '84, SM '86, PhD '92. It had an improved design, a spirit-rousing rainbow paint job, and the best times in the early qualifying races for the Third International Human-Powered Submarine Race last summer in Fort Lauderdale. Then the hopes of victory were dashed by miserable weather and puzzling mechanical failures. But the team is bouncing back and will soon be hard at work in the cramped confines of Building E20, preparing for the 1995 race.

MIT has entered a craft every year the race has been run. At ten and a half feet, the *Sea Beaver II* is two inches longer, and with the addition of dive planes, a lot more maneuverable than its predecessor. As specified in the rules drawn up by the Perry Foundation and Florida Atlantic University, each sub carries a pilot and a pedaller. MIT's first-string crew, triathlete Kite-Powell and pilot William Hall, '91, SM '92, are both seasoned veterans of the Sea Beaver program.

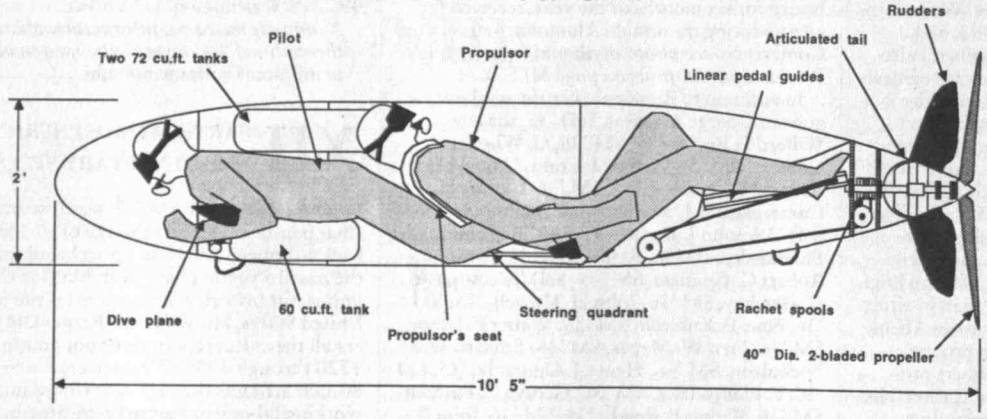
The races take place in open ocean at depths of up to 25 feet and with visibility occasionally as little as 4 feet. Traditionally, the pairing of boats that will compete simultaneously in the 400-meter-race is determined by 100-meter speed trials. Due to rough seas and low visibility, of the 48 competing subs, only 24 were able to post speeds in the 100-meter event (MIT posted the second-fastest time). With bad weather continuing to be a factor, the organizers were forced to hold the final event—the 400-meter races, usually conducted over several days—all on the last day of the competition.

Once MIT got into position for the race, two independent failures of the drive mechanism prevented the submarine from ever leaving the starting line. The crew still hasn't been able to come up with a scenario for how the malfunction could have developed, but it's made them all the more determined for next time.



Team members and crew of the **Sea Beaver II**, *MIT's human-powered submarine, arrayed in front of their brilliantly painted craft the day of the race: Dave Gerson, '92, SM '93; Drew Bennett, '87, G; Jacqueline Brener, '96; Bennett Zarren, '61; pilot Bill Hall, '91, SM '92; Leah J. McGavern, G; Cliff Goudey, SM '77, project leader; propulsor Hauke Kite-Powell, '84, SM '86, PhD '92; Brodie Hynes, '96; and Diane E. DiMassa, G. Not pictured: Joice Himawan, '83, '85, and Jenny Donner (who piloted the truck to and from Florida). The multi-disciplinary team brings the diverse insights of Courses II, VI, XIII, and XVI to its enterprise.*

HPS Sea Beaver II



A tight squeeze indeed: two divers occupy nearly every inch of this sub. The propulsor has no line of vision and must rely on the pilot for commands. The **Sea Beaver II**'s *handling has improved over its predecessor's in that the pitch is now controlled by the pilot's hands and the heading controlled by his or her feet; before, all such controls were combined into one lever.*

ILLUSTRATION: C. GOUDEY

The *Sea Beaver II* exacerbates a major downside of submarines, their lack of brakes, by having no reverse gear. Running into an obstacle or turning the vessel directly upward are the only ways to stop quickly—and in order to accomplish the latter, there must be enough room and advance notice to swoop down and then up. The sub has crashed into the sides of training pools more than once, and last year on a test run in the murky Florida waters, the *Sea Beaver II* ran into a stationary barge. Fortunately, there were no injuries for the crew or irreparable damage to the craft.

Sea Beaver II is a project of the MIT Department of Ocean Engineering and the Sea Grant program, and is headed by Clifford Goudey, SM '77, a fisheries engineer with Sea Grant. As of 1993, the *Sea Beaver* also has support from the Edgerton Center, a one-year-old program established by the Edgerton Foundation to nurture the hands-on spirit of Harold E. ("Doc") Edgerton, SM '27, ScD '31, among MIT undergraduates.

Another important break for *Sea Beaver* in 1993 was that Bennett Zarren, '61, came on board as fund raiser, major force behind the vibrant paint, and ad hoc director of public relations. A Florida-based alumnus with a reputation for not taking "no" for an answer, Zarren believes that *Sea Beaver* is a prime example of the can-do spirit in action that ought to exemplify MIT to the rest of the world. He not only supports the team himself—occasionally wielding the sander and paint gun as well as providing resources—but he also hosted a reception for prospective donors to introduce them to the sub and its team. Half of the time that students invest on projects like the human-powered submarine is often taken up by fund raising, says Zarren, and that time could be much better spent on technical improvements and training.—*Sherrie Saint John*□

Spindle Whorls in Archaeology." . . . **Paul Gordon**, '39, SM '40, professor emeritus of metallurgical and materials engineering at Illinois Institute of Technology, has been given the 1993 Albert Easton White Distinguished Teacher Award from ASM International. ASM has given the award annually since 1960 to recongize unusually long and devoted service in the teaching of materials science and materials engineering, coupled with an unusual ability to inspire and impart enthusiasm to students. The award is named for a co-founder of the professional society and the recipient is selected from top teachers around the world. Gordon, who joined IIT's faculty in 1954, was cited for his tireless devotion as an educator and mentor.

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XIII OCEAN ENGINEERING

Donald M. Reynerson, SM '75 (II), NA '75, has joined Construction Systems Associates, Inc., as VP, director of nuclear projects. CSA, headquartered in Marietta, Ga., is an engineering and software services company, that "specializes in the development and implementation of three-dimensional database configuration management models in order to improve the efficiency and quality of the management of large facilities." Reynerson is responsible for nuclear program business development and project implementation. He was previously with the Institute of Nuclear Power Operations (INPO), and was responsible for management reviews of American commercial nuclear power operating plants. He was also responsible for INPO engineering and construction programs in support of the Advanced Light Water Reactor program. Reynerson was the completing construction director at the Comanche Peak Stream Electric Station, and the director of Nuclear Plant Engineering at the River Bend Nuclear Station. He also served as project manager at Lawrence Livermore National Laboratory, and as an engineering day officer in the U.S. Navy nuclear submarine programs. . . . Three alums have reported for Naval duty: Commander **Gregory Vaughn**, SM '88 (II), OCE '88, has assumed command aboard the submarine USS *New York City*, homeported in Pearl Harbor, Hawaii; Lieutenant **Mark E. Davis**, SM '93, aboard the submarine USS *Aspro*, also homeported in Pearl Harbor; and Captain **Randolph M. Brooks**, SM '76 (XXII), OCE '76, at Navy Sea Systems Command Headquarters in Washington, D.C.

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XIV ECONOMICS

Margaret Garritsen deVries, PhD '46, writes: "In my seventh year of retirement after 40 years with the International Monetary Fund, I continue to be active, giving speeches and writing articles on the world economy and on the IMF, particularly as the IMF is about to celebrate the 50th anniversary of the Bretton Woods conference that created IMF and the World Bank." . . . **Kathleen F. Feldstein**, PhD '77, has been named to the board of directors at John Hancock Financial Services in Boston. She continues as president of Economic Studies, Inc., in Belmont, Mass. . . .

Howard Rosenthal, '60, PhD '64, has been named the Roger Williams Straus Professor of Social Sciences in the Department of Politics at Princeton University. An expert on formal and quantitative political analysis, he has taught at Carnegie-Mellon University. He joined the Princeton faculty this past summer, after two years as a Fellow at the International Center for Economic Research in Turin, Italy.

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XV MANAGEMENT

Kimberly Ritrievi, SM '85, ScD '85 (X), writes: "I am now a senior VP at Lehman Brothers in New York City. I've been an equity research analyst for the past six years—the industries I follow are speciality chemicals and photography. In my limited spare time, I enjoy New York immensely and spend as much time skiing in Utah and Colorado as possible." . . . From Arlington, Mass., **Robert H. Falstad**, SM '93, reports: "As a senior consultant for International Systems Services (ISS) Corp., I am performing information technology consulting with particular emphasis on workflow management. ISS is a management consulting firm specializing in buiness process reengineering. I am assisting the startup effort for the Boston office of ISS." . . . **Paul K. Stedman**, SM '89, sends word: "My wife, Martha, and I are expecting our first daughter in January, 1994. In preparation for the family we will be moving from Manhattan back to Dallas in September. Things continue to go well at BSG Consulting, Inc. (a small client/server technology firm based in Houston), and with the continued growth in the technology, there is never a dull moment."

Erika Williams

Erika Williams, SM '78, has been named general manager of data storage products at Amdahl Corp. in Sunnyvale, Calif. Williams joined Amdahl in 1978, and has held senior positions in corporate planning, manufacturing, hardware and software development, and marketing, most recently as VP for compatible products marketing. Prior to this, she spent several years in the information systems group at Arthur D. Little. . . . **William E. Wade**, SM '68, has been named to the board of directors at Lyondell Petrochemical Co., in Houston, Tex. Wade remains executive VP at Atlantic Richfield Co. in Los Angeles. . . . **Mark A. Lester**, SM '90, has been promoted to VP for operations of Kemper-Masterson, Inc., of Belmont. Lester has been with KMI since 1991, when he joined as senior consultant. Recently, he was director of operations. Lester resigned as a lieutenant from the Navy's Nuclear Submarine Force in 1988 after five years of service. . . . **Lawrence S. Daniels**, SM '66, (II), SM '66, has been named VP for strategic planning at Biogen, Inc. Prior to this he was VP for marketing and business development at the Cambridge-based company.

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Sloan Fellows

Fredric Abramson, SM '77, writes: "I've started a new software company called United Software Associates, Inc. We bring European software to America. Our first two products were released this fall. First is SWING, a Swiss product for all PCs and LANs that simplifies Windows and DOS, letting ordinary people use computers much like they use televisions and telephones. It is fully integrated with e-mail, security, tools, screen savers, PIM, and more. The second is Manage!. Manage! profiles how people actually think when they make decisions by tracking their activities in a 2.5-hour simulation. Without any true-false/multiple-choice questions, it reveals styles in information search, task vs. people orientation, aggressive-conservative tendencies, and more." . . . **Kay Whitmore**, SM '75, is resigning as chair and CEO at Eastman Kodak in Rochester, N.Y. . . . Also retiring is **Heinz K. Fridrich**, SM '65, as VP for manufacturing at IBM Corp., in Somers, N.Y.

Roman J. Krygier, Jr., SM '74, has been named general manager of Ford Motor Co.'s Body & Assembly Operations in North American Automotive Operations. Krygier, previously assembly operations manager since 1992, joined the company in 1964 as a trainee foreman at the Chicago Stamping Plant. After a series of supervisory and management positions in Stamping Operations, he was named manufacturing manager of the Woodhaven, Mich., Stamping Plant in 1975, and manager of the Buffalo, N.Y., Stamping Plant in 1977. . . . **Susan Brady**, SM '87, has joined New England College as its new VP for student development and dean of student affairs. Brady has been in student personnel for more than 20 years. Prior to joining New England College, she was dean of students at Johnson State College, and vice-provost at Gettysburg College. Brady has served as state coordinator of the ACE Office of Women, is an active leader in a number of professional associations, and is a member of the Nature Conservancy and the National Trust for Historic Preservation.

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Senior Executives

Harvey L. Weiss, '81, has resigned as president and COO of Thinking Machines, Inc., in Cambridge.

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Management of Technology Program

Sorab Vatcha, SM '85 (X), has contributed to another article, entitled "Managing Innovation," in the August 11, 1993, issue of *Inside R&D*. . . . **B. Joseph Pine II**, SM '91, is now president of Strategic Horizons, Inc., a consulting firm based in Ridgefield, Conn. He recently co-wrote an article for the September-October 1993 *Harvard Business Review* entitled "Making Mass Customization Work." . . . **Brian Fees**, SM '93, recently spoke with the current (1993–94) self-sponsored MOT Program participants, discussing job searches, market conditions, and potential salary ranges. His presentation provided useful insights and was very well received.

Stan A. Smith, SM '93, has co-written a working paper with MIT Professor Michael Cusumano, entitled "Beyond the Software Factory: A Comparison of 'Classic' and PC Software Developers." The paper has been published by the International Center for Research on the Management of Technology, and was released in September. Congratulations, Stan! Stan has also moved to Austin, Tex., and is working on a new operating system for IBM. . . . **Nevin Summers**, SM '93, has been appointed research affiliate at the MIT Program on the Pharmaceutical Industry. In this para-academic position, he plans to continue the work he began in his thesis on the emergence of gene therapy in the pharmaceutical industry.—MOT Program, MIT, Room E56-290, Cambride, MA 02139.

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XVI AERONAUTICS AND ASTRONAUTICS

Peter Benjamin, SM '66, sends word from Garrett Park, Md.: "Last March I accepted the position of assistant general manager for finance and comptroller of the Washington Metropolitan Area Transit Authority. Responsibilities include finance, budgets, accounting, grants, risk management, safety, management information systems, and the transit police."

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XVII POLITICAL SCIENCE

From Alexandria, Va., **Cynthia Womack**, SM '92, writes: "I am working for a defense contractor doing policy analysis and following congressional issues relating to the clients' strategic nuclear weapons programs. I am getting married in November 1993." . . . **Stephen Amberg**, PhD '87, sends word: "This past spring I was promoted to associate professor of political science with tenure at the University of Texas at San Antonio. I have written a book, *The Union Inspiration in American Politics: The Autoworkers and the Making of a Liberal Industrial Order*, which was published by Temple University Press late last year. Since moving to San Antonio, I have married Anne Sullivan, who is a nurse practitioner (from the now-defunct Boston University graduate program) at Planned Parenthood, and we adopted a daughter, Nora, who is a wonderful two years old."

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CASE OF MISTAKEN IDENTITY . . .

In the October 1993 issue we misidentified a Course XVII graduate in the photo on page MIT 52. The alumnus identified as Angel A. Del Valle, '43, was actually **Angel M. Gonzalez**, '43. Both reside in San Juan, Puerto Rico, but Del Valle is a Course II graduate and Gonzalez was in the old Course XVII (Building Engineering and Construction); since 1964 XVII has been known as Political Science.

Angel Gonzalez

XVIII MATHEMATICS

From Houston, Tex., **L. Ridgway Scott**, PhD '73, writes: "I am director of an NSF Grand Challenge Application Group, established in September 1992, focusing on computational molecular design. Particular applications are in the design of new pharmaceuticals. We are using mathematics to design new parallel algorithms suitable for scalable parallel supercomputers." . . . **John Lukas**, PhD '67, reports: "I am in the Mathematics and Computer Science Department at the University of Massachusetts at Boston, where I have recently been promoted to professor. My current research is in the area of optimizing compilers for massively parallel computer systems." . . . From Senoia, Ga., **Jan List Boal**, PhD '59, writes: "My wife, Bobby, and I celebrated our 40th wedding anniversary with a nine-day trip to Spain. We thoroughly enjoyed the art treasures in Madrid, El Escorial, and Seville, and learned a little Spanish!" Jan reports that **George C. Bush**, SM '56, and his wife, Emmeline, have recently returned from Turkey where George taught computer science and served as a missionary for Interserve. He is now living in Nova Scotia, Canada. . . . **Henry M. Walker**, PhD '73, professor of mathematics and computer science at Grinnell College in Grinnell, Iowa, has written *The Limits of Computing* (Jones and Bartlett Publishers, Inc., 1993). Using non-technical stories and examples, the book explains the theoretical limits and practical constraints facing.computer users. The inability to plan for *every* contingency, the logistics of the time needed to solve huge problems, and the impossibility of solving other problems are among the issues explored.

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XX APPLIED BIOLOGICAL SCIENCES

Alfred Doig, Jr.

Alfred R. Doig, Jr., SM '76, has been appointed VP for university relations at Worcester Polytechnic Institute. Doig joined WPI from MIT, where he was assistant dean for development in the School of Engineering. University Relations at WPI raises funds from alumni/ae and other individuals, foundations, and corporations; provides news and public relations services for the institute; and edits and produces the university's many publications. Doig joined MIT in 1987 as director of the metropolitan New York district of the University's National Campaign Office, helping coordinate volunteer activities for MIT's $700 million capital campaign. In 1988 he transferred to the Office of Major Gifts, where he coordinated MIT's major gift activities in the Metro New York area. He was named director of development for the School of Engineering in 1989 and was promoted to assistant dean later that same year.

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XXII NUCLEAR ENGINEERING

James K. Liming, SM '83, writes from Fountain Valley, Calif.: "I am currently the Southern California branch office manager for Erin Engineering and Research, Inc., where I supervise and perform risk analysis and reliability engineering services for complex facilities worldwide." . . . **J. H. Goldberg,** SM '60, reports from Jupiter, Fla.: "I am president of Florida Power & Light's Nuclear Division, which owns and operates four nuclear plants." . . . From Augusta, Maine, **Jeffrey H. Musk,** SM '88, sends word: "I will be living in Seoul, South Korea, for the next two years serving with the army." . . . **Vincent P. Manno,** SM '78, NUE '79, ScD '83, writes to tell us that he has been appointed chair of the Department of Mechanical Engineering at Tufts University. Mass. Manno lives in Sudbury, Mass. . . . **Ken Brooks,** SM '89, reports: "I have just finished a PhD this summer in the Woodruff School of Mechanical Engineering's Radiological Engineering programat the Georgia Institute of Technology. My major research involved diagnostic medical physics pertaining to automated image quality of mammographic images. I have also just accepted an appointment as assistant professor in the Department of Radiation Oncology of the Emory University School of Medicine. Prior to entering the PhD program and after MIT, I had spent a couple of years at IBM as a systems engineer. Karen, my wife of two years, and I currently live in Northwest Atlanta."

Frederick W. Buckman, PhD '70, president and CEO of Consumers Power Co., in Jackson, Mich., has received the George Westinghouse Gold Medal of the ASME. Buckman received the medal, established in 1952, for his "exemplary leadership in support of the nuclear power option in the United States, for pioneering vision and tireless energy in championing the development and promotion of the Modular High Temperature Gas-Cooled Reactor, and for distinguished technical contributions in nuclear fuel performance improvement and reactor analysis methods." Since the mid-1980s, Buckman has been part of the management team that has converted an abandoned nuclear plant into the nation's largest combined-cycle natural gas cogeneration facility, the Midland Cogeneration Venture. His other major projects and activities include the $90-million steam generator replacement project at Palisades, improved nuclear operating and regulatory performance, improved electric distribution and transmission system performance, high performance in generating efficiency and safety, and a resolution of all outstanding MCV financial issues. . . . Captain **Randolph M. Brooks,** SM '76, OCE '76 (XIII), has reported for duty at Naval Sea Systems Command Headquarters in Washington, D.C.

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TPP TECHNOLOGY AND POLICY PROGRAM

Jean Bernard, SM '81, and Fabienne Caen have an additin to their family. Barthelemy was born July 15, 1993, and joins his brother, Timothee, who is now three. . . . **Win Hayward,** SM '81, dropped by TPP while visiting Cambridge to tell us he is now the director of Multi-Family Housing for Fannie Mae (FNMA, Federal National Mortgage Association) and is the company's guru on lead paint in housing. . . . **Franz Neubacher,** SM '83, visited MIT this past summer. He has founded an environmental consulting company, UV&P-Neubacher and Partner, doing innovative environmental management and incineration work in Austria and Germany. He also reports that he miraculously survived an extroaordinary automobile crash and is lucky to be alive. . . . **Eric Paillas,** SM '84, is still with GTM participating in the construction of a major bridge between England and Wales. Eric now lives in Bristol and has two daughters, Claire and Juliette. . . . **Francois Jacques,** SM '85, dropped by TPP to say he has been director of strategy and part of the management team of Ciments Lafarge, a $1-billion-per-year company, since early 1993—Bravo and Bonne Chance! . . . **Louisa Koch,** SM '88, is currently with the U.S. Office of Mangagement and Budget. . . . **Lola Matysiak,** '91, SM '92, has announced her engagement. A 1994 wedding is planned.

Steve Thomas, SM '92, has moved to Chicago to be an investment analyst with Euro American Arbitrage. . . . Congratulations are in order for **Ram Josyula,** SM '93, and Elaine. They are planning a June 1994 wedding. . . . **Kok-Kee Lim,** SM '91, EE '92 (VI), SM '93 (XIII), SM '93, is a research engineer with the Ministry of Defense in Singapore. . . . **Hotasi Nababan,** SM '93 (I), SM '93, now in corporate planning and development at Garunda Indonesia, recently accompanied his directors to Cambridge to negotiate a contact for their airline with MIT. . . . **Renata Pomponi,** '90 (VIII), SM '90 (XXI), was a member of the rowing team that won the gold medal at the Bay State Games this past summer. . . . **Adil Najam,** spent his summer co-editing *Papers on International Environmental Negotiation* with Professor Lawrence Susskind, MCP '70, PhD '73 (XI), of MIT and Professor William Moomaw, PhD '65 (V), of the Fletcher School of Law and Diplomacy at Tufts. The book was published by the Program on Negotiation at Harvard Law School and will be one of the prescribed texts for a course on international environmental negotiation. Adil's own paper in the book is on North-South environmental policy—Richard de Neufville, TPP, MIT, Room E40-252, Cambridge, MA 02139.

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STS PROGRAM IN SCIENCE, TECHNOLOGY & SOCIETY

Hugh Gusterson presented "The Ethics of Nuclear Weapons Work: Some Problems for Carol Gilligan" at the meetings of the International Society for Political Psychology in Cambridge, Mass., in July. His article "Realism and the International Order After The Cold War" was published in *Social Research 60* . . . **Lily Kay** presented three lectures on the history of biochemistry and molecular biology at the XIX International Congress of History of Science held in August in Zaragoza, Spain. . . . **David Ansley,** a science and medical reporter for the *San Jose Mercury News* will serve as acting director of the Knight Science Journalism Fellowships this year. Ansley is filling in for director Victor McElheny, who is on leave from MIT while he writes the biography of Edwin Land.—Graham Ramsay, STS program, MIT, Room E51-128, Cambridge, MA 02139.

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ALLAN J. GOTTLIEB, '67

An Upscale Weight Problem

This being the first issue of a calendar year, we again offer a "yearly problem" in which you are to express small integers in terms of the digits of the new year (1, 9, 9, and 4) and the arithmetic operators. The problem is formally stated in the "Problems" section, and the solution to the 1993 yearly problem is in the "Solutions" section.

Problems

Y1994. Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 9, and 4 exactly once each and the operators +, -, x (multiplication), / (division), and exponentiation. We desire solutions containing the minimum number of operators; and, among solutions having a given number of operators, those using the digits in the order 1, 9, 9, and 4 are preferred. Parentheses may be used for grouping; they do not count as operators. A leading minus sign does count as an operator.

JAN 1. Theodore Hoffman is dismayed to realize that he gains weight just by moving his scales. He writes:

The puzzle surfaced when I moved my bathroom "Detecto" scales from a section of bare wood floor to a rug. Imagine my surprise when I found that, according to the scales, I had gained 10 pounds in the process of moving them. So, I made a few readings under varied conditions. Here they are:

Object	Scales Location/Reading on Scales			
	On floor or wood	On 3/8" foam pad	On 5/8" pile rug	On 3/4" wood on top of rug or foam
Scales alone	0	0	0	0
Me	145	153	155	145
2 weights	181/2	191/2	193/4	181/2

(The Detecto scales register from 0 to 255. The overhang of the weight-carrying top platform clears all surfaces by 3/8")

My curiosity abounds as to the explanation.

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012, OR TO: GOTTLIEB@NYU.EDU

JAN 2. Donald Savage asks: The present U.S. flag has 50 stars arranged in alternate rows of 6 and 5. If Puerto Rico were to become a state, what would be an appropriate arrangement of the stars on the revised U.S. flag?

Speed Department

Speedy Jim Landau wants to know what is the matter with the function

$$f(\lambda) = \frac{1}{\lambda + \sin(\lambda)}$$

where L is the latitude?

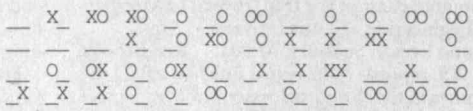
Solutions

Y1993. The following solution is from John Drumheller:

1 1^{993}	30 (19-9)*3	59 -
2 93-91	31 19+9+3	60 (1+9)*(9-3)
3 1^{99}*3	32 (9/9)+31	61 -
4 1^{99}+3	33 (1*99)/3	62 -
5 9-13+9	34 1+(99/3)	63 (9-3+1)*9
6 ((1*9)+9)/3	35 (9*3)-1+9	64 91-(9*3)
7 19-9+3	36 (13-9)*9	65 -
8 (9*3)-19	37 1+9+(9*3)	66 9+(3*19)
9 1^{93}*9	38 39-1^{9}	67 -
10 1^{93}+9	39 1^{9}*39	68 99-31
11 (9/3)-1+9	40 1^{9}+39	69 ((9-1)*9)-3
12 13-(9/9)	41 -	70 -
13 19-9+3	42 -	71 -
14 13+(9/9)	43 -	72 (9+9)*(3+1)
15 (1*9)+9-3	44 -	73 -
16 19-(9/3)	45 ((3+1)*9)+9	74 93-19
17 (9*3)-1-9	46 19+(9*3)	75 3-((1-9)*9)
18 (9*3*1)-9	47 9+39-1	76 -
19 1-9+(9*3)	48 (1*9)+39	77 (9*9)-3+1
20 39-19	49 31+9+9	78 (1*9*9)-3
21 (1*9)+9+3	50 (9*9)-31	79 91-9+3
22 19+(9/3)	51 (9-1+9)*3	80 (9*9)-1^{3}
		81 (1/9)*9^{3}
		82 (9*9)+1^{3}
		83 93-1+9
		84 (19+9)*3
		85 1-9+93
		86 99-13
		87 ((1+9)*9)-3
		88 91-(9/3)
		89 -
		90 $9^{(3-1)}$+9
		91 -
		92 93-1^{9}
		93 1^{9}*93
		94 1^{9}+93
		95 99-1+3
		96 (1*99)-3
		97 1+99-3
		98 99-1^{3}
		99 -1^{3}*99
		100 1^{3}+99
23 -	52 91-39	
24 ((9-1)*9)/3	53 ((9+9)*3)-1	
25 19+9-3	54 ((1*9)+9)*3	
26 ((9*9)/3)-1	55 1+((9+9)*3)	
27 (1*9*9)/3	56 -	
28 1+(9*9/3)	57 (19*9)/3	
29 39-1+9	58 19+39	

A/S 1. The late Bob High wanted to know the longest legal go game on a 2x2 board with no passes.

The following solution was from the proposer himself: Note that by the "ko" rule, a legal game cannot repeat a game position with the same player to move. The longest legal game on a 2 x 2 board without passes is 23 moves (24 positions); it is given by:



(There are a total of 57 legal positions on the 2 x 2 board; 8 if we all take symmetries into account. The longest legal game *with passes* I've been able to construct has over 50 moves, and traverses 44 of the legal positions!)

A/S 2. Thurston Sydnor wonders where, in the first quadrant, the curve $x^y = y^x$ intersects itself.

Al Cangahuala writes that one solution to the equation is clearly $x=y$. One can find where the second solution intersects this line by performing the substitution $y=kx$. Then $x^{kx}=(xk)^x$ and thus $x=k^{1/(k-1)}$. We get the x-coordinate of the intersection by taking the limit as k approaches 1 (since the intersection occurs at the $x=y$ line. But, letting $n=1/(k-1)$ we get that

$$\lim_{k\to 1} k^{1/(k-1)} = \lim_{n\to\infty} (1/n+1)^n = e$$

So the point of intersection is (e,e).

A/S 3. Dave Mohr has noticed that the temperature sign in his bank alternates integer readings expressing Fahrenheit and Celsius. Assuming that the readings are perfect (and perfectly rounded), for what temperature(s) is one's uncertainty of the precise temperature at a minimum?

The following solution is from Eric Lund: Let F be the thermometer reading in degrees Fahrenheit and C be the thermometer reading in degrees Celsius. Let F_{nom} and C_{nom} be the exact temperature, i.e., $F_{nom}=1.8\ C_{nom}+32$. If (F,C) is a solution to this problem, then for all integers n, $(F+9n,\ C=5n)$ is also a solution. Therefore we need only consider the range $32 \le F \le 41$, $0 \le C \le 5$. Construct the following table:

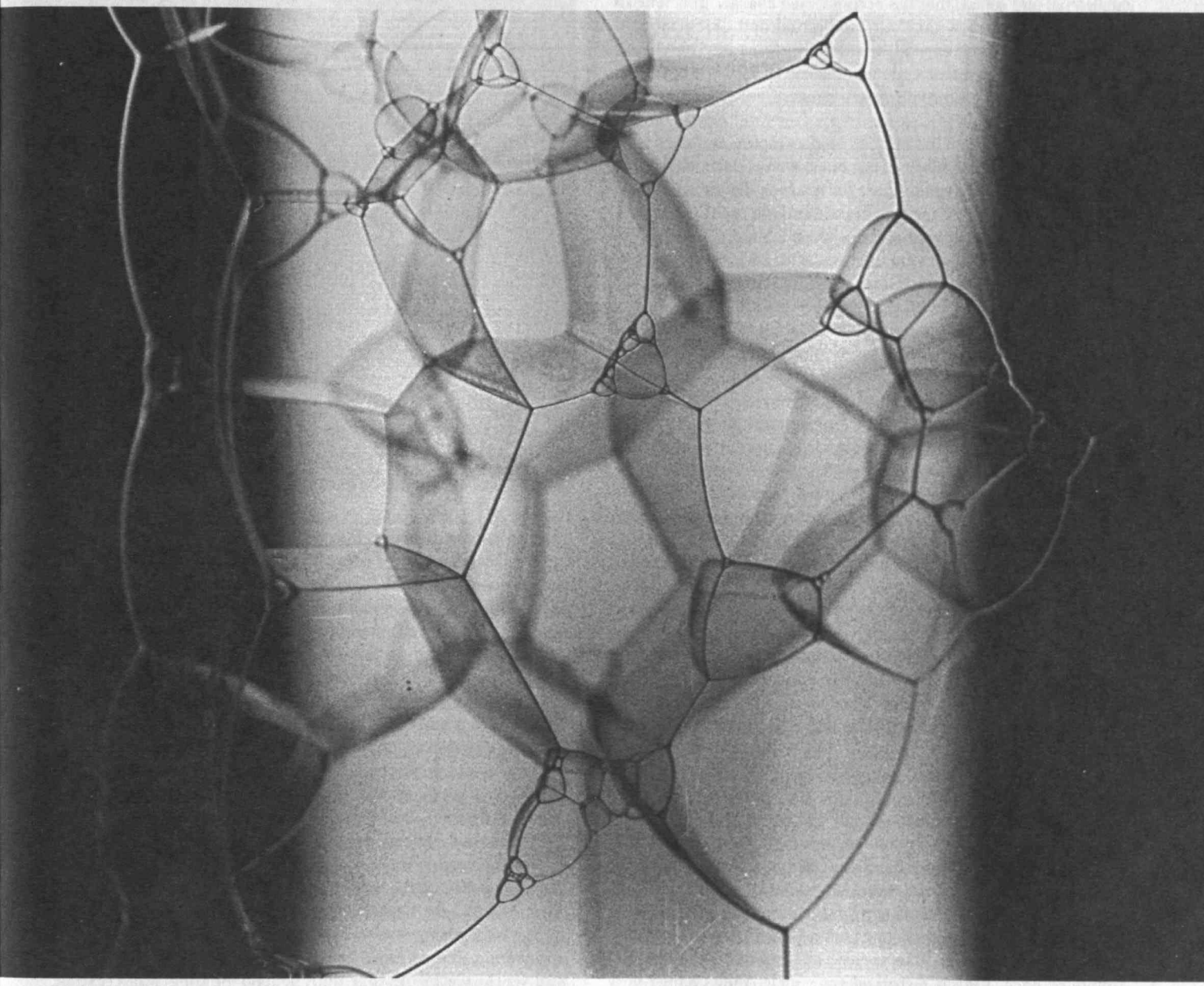
C	F	F_{min}	F_{max}
0	32	31.5	32.5
0	33	32.5	32.9
1	33	32.9	33.5
1	34	33.5	34.5
1	35	34.5	34.7
2	35	34.7	35.5
2	36	35.5	36.5
3	37	36.5	37.5
3	38	37.5	38.3
4	38	38.3	38.5
4	39	38.5	39.5
4	40	39.5	40.1'
5	40	40.1	40.5
5	41	40.5	41.5

From the table we see that for any integer n, the combinations $F=9n+35$, $C=5n+1$ and $F=9n+38$, $C=5n+4$ give the temperature to within 0.2 degrees Fahrenheit.

Continued on Page MIT 40

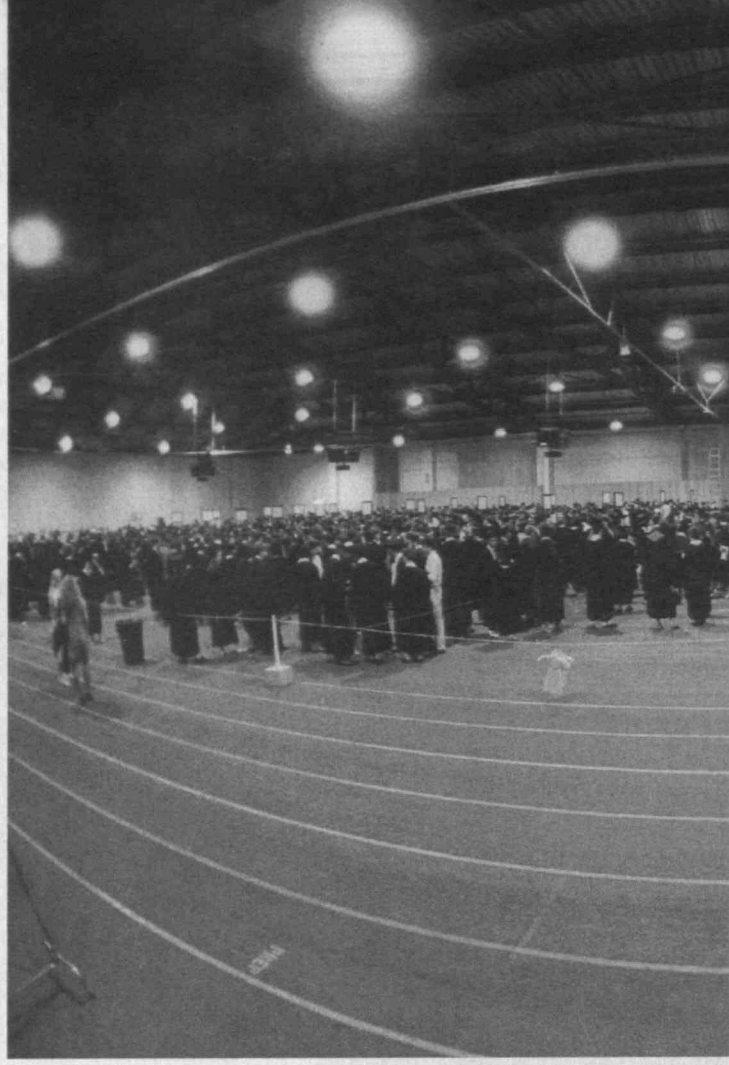
REPORT OF THE PRESIDENT

For the Academic Year 1992–1993



STILL FOLLOW SENSE, OF EV'RY ART THE SOUL,
PARTS ANSWERING PARTS SHALL SLIDE INTO A WHOLE.

Alexander Pope, *Epistles to Several Persons*



These are times of change that call for a rethinking of how American higher education can best serve the nation and the world. As our universities and colleges evolve to meet the new intellectual and social challenges before us, we must find ways to deal with the fragmentation, both intellectual and social, that has accompanied change. It is time to seek a new balance within our intellectual and organizational constructs. Our fundamental values will help us stay on course, but we need a vision that embraces the complexities of our times while helping us to move toward greater coherence around common goals.

The American dream has become more complex, and the people who dream it are more diverse, but our higher educational system remains the most important vehicle for reaching that dream.

At one level, the American dream and the goals of higher education remain congruent and unchanged. Simply put, they are to provide the opportunity and the means for each person to meet his or her needs and aspirations and to contribute to the well being of our society—with understanding, skill, responsibility and, one would hope, with compassion.

These goals are fostered by a set of fundamental values that are held in common by essentially all institutions of higher learning. We believe in the importance of education, of rationality and objectivity, and of discovering and transmitting knowledge. We respect varying views, value the role of our institutions as critics of society, and believe in an elitism that is based solely on talent and accomplishment, rather than wealth or social status. As a corollary to this last point, we believe that in a democratic society, our institutions of higher education must be both excellent and accessible—for the sake of the individual and for the sake of society.

These values give continuity of purpose to our colleges and universities. At the same time, they ensure that we will encounter continual change in the students we educate, in the faculty who teach them, and in the expectations of both. So, too, we will continually generate change in what we teach, in how we teach, and in the fields we invent and discover.

CHANGE

Sometimes intellectual, social, and organizational changes are precipitated by sudden, dramatic events or insights followed by a long period of diffusion and adjustment throughout an institution. More often, they come slowly and painfully, as a result of adjusting to the tensions that arise from conflicting forces, goals, and realities.

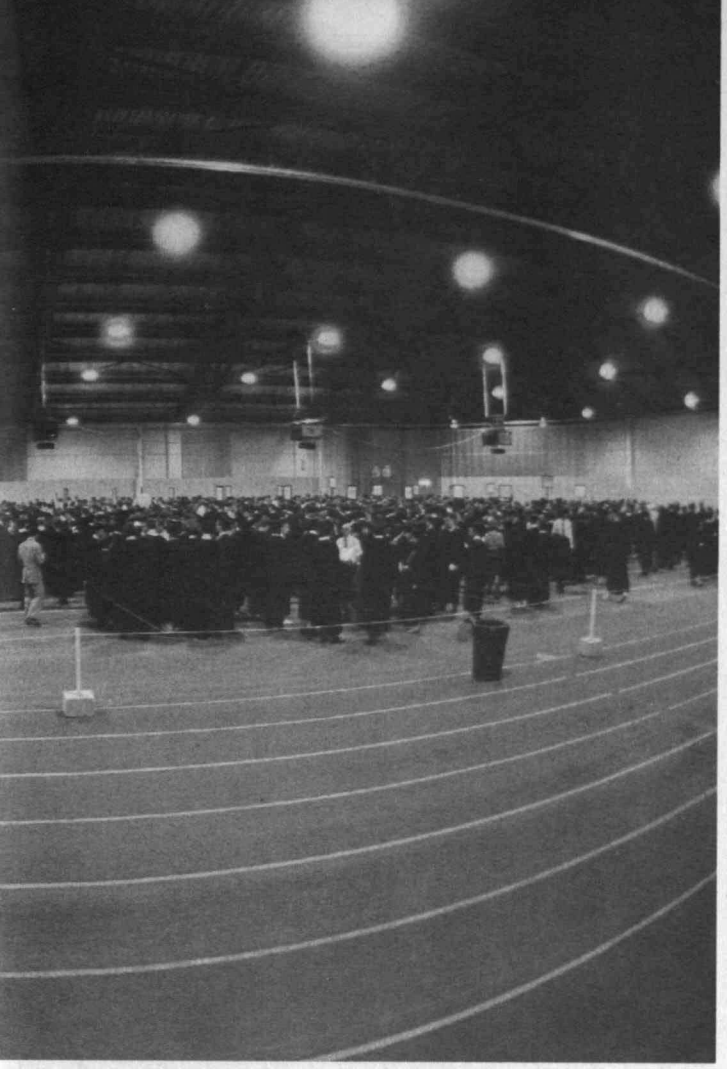
American campuses, like society as a whole, change at an awkward pace. On an historical time scale, they change very quickly. On the time scale of a faculty member's career, they change slowly enough to be missed in day-to-day perception, but rapidly enough to create confusion of goals over time. On the time scale of an undergraduate's education, they seem to change not at all.

The student body of MIT has changed remarkably since the time of the Institute's founding, when a group of 15 young men gathered in Boston at the end of the Civil War to study the practical arts and sciences that would serve the needs of a rapidly industrializing society. Today, MIT's students are a remarkably heterogeneous group of nearly 10,000 men and women who come to our Cambridge campus from all over the world to study in fields ranging from molecular biology to music composition, from computer science to economics. One-third of the graduate students now come from other countries, as do nine percent of the undergraduates. The undergraduates, one-third of whom are women, are a particularly diverse group. Of those who are US citizens or permanent residents, 56 percent come from the majority white population, approximately 28 percent are Asian Americans, 9 percent are Hispanic Americans, 6 percent are African Americans, and 1 percent are Native Americans.

By contrast, when I began my teaching career in the mid 1960s, engineering was widely regarded as a man's world and it was rare to have more than one or two women in an engineering class. Most of my students were born in this country, and most were white. For the most part, students, especially in science and engineering, shared rather common personal goals, aspirations, and world views. At that time, federal funding was creating rapidly growing research programs, mostly at a handful of leading institutions. The structure of DNA had only recently been discovered, computing was done by batch processing of programs entered on punched cards, and the engineering science revolution was propagating from MIT to the rest of the country.

A faculty member looking back over three decades sees social and intellectual changes that have been significant, even

PHOTO ON PROCEEDING PAGE: MIT COMMUNICATIONS OFFICE/JOSHUA WACHMAN



dramatic, but consider how things must look to a graduating senior reviewing his or her four years at MIT. Since the Class of 1993 entered in 1989, the General Institute Requirements have changed only by one subject, molecular biology. The organizational structure remains pretty much the same, although the deans of every School are new and two departments have changed their names to reflect new emphases. The campus looks about the same, with the very notable exception of the Biology Building rising on Ames Street.

To put it simplistically, students think nothing changes. Many faculty and administrators view the world through eyes that grew accustomed to the academic light 20, 30, or 40 years ago. And William Barton Rogers would be hard put to discern any connection between today's MIT and the Institute he founded.

Intellectually, we have sometimes advanced in sudden bursts, as when an entirely new approach to technological development and applied research was created in the World War II Radiation Laboratory, or when Noam Chomsky reconceptualized linguistics, or when Edward Lorenz developed the basic ideas of chaos theory. More often, we have slowly and collectively evolved ideas, approaches, and academic disciplines by a combination of incremental insights, external forces, and growing infrastructure.

Organizationally, we adjust to changing circumstances. Traditionally, the pattern has been the following: Research leads to the establishment of laboratories and the creation of graduate subjects. Graduate subjects are combined to form graduate programs, and as the intellectual mass develops and as demand for graduates and applications accumulates, departments are formed. Faculty entrepreneurism, both intellectual and in terms of developing funding for research and education, have been and remain essential elements of change. The administration and support services of the Institute have developed to meet growing faculty and student needs and to deal with the ever-increasing administrative requirements of government funding and regulation. Thus, we now have major institutional organizations to provide our scholars with information technology resources, to attract financial support from individuals, foundations, and corporations, and to provide housing, food, advising, and medical services to our students.

Socially, we also adjust to evolving circumstances, but often only with difficulty. MIT is a collection of extraordinary individuals who, time and again, have redefined intellectual fields and have risen to the challenges presented by the larger society. And now these challenges include incorporating more rapid cultural and demographic change into our life as an academic community. In the past four years, the number of underrepresented minority students has increased by 9 percent, while the number of minority students overall (that is, including Asian American students) has increased by 26 percent. At the faculty level, the number of women in the professorial ranks, while still small, has increased by 15 percent (from 95 to 109). The number of underrepresented minority faculty has increased by 15 percent as well, but remains distressingly low, at 31.

Many of the changes that we face today—some with relish, and some with anxiety—seem to me to have in common tensions between fragmentation and coalescence. Furthermore, they cannot be classified neatly as intellectual, organizational, or social, but involve all three aspects simultaneously. As I contemplate these changes, I have come to believe that there is a growing imperative to de-emphasize fragmentation and to reemphasize coalescence. We must seek greater commonality of vision in the many dimensions of our life at MIT.

THE MULTICULTURAL CAMPUS

As noted, the gender, race, and ethnic composition of MIT is far different than it was three decades ago, and is characterized by remarkable heterogeneity, especially among the students. Even though MIT is a more focused institution than most, we find that the values and aspirations among our students are increasingly diverse as well. This heterogeneity, depending on the context, is viewed as providing a great resource and opportunity, as demanding new institutional services and responsibilities, or as establishing new tensions on campus. Each of these views is correct. None can be escaped.

As faculty and administrators across the country grapple with these new realities, they are caught in a vise of political opinion – the "politically correct" arguments of the left and of the right. From the left, political correctness condemns us if we do not fragment every academic subject indefinitely along gender, racial, ethnic and other lines. It seems to strive to make us so

PHOTO: PAULA LERNER

self-conscious about differences, terminology and "isms" that open, objective, intellectual and social discourse becomes both difficult and unproductive. On the other hand, the politically correct on the right cry "quota" and "standards" at the first sighting of a minority student on a prestigious campus; find it inappropriate when our studies of history, politics, and literature become more inclusive and view the world through many eyes and experiences; and see the decline of American civilization if a group of black students eat together in the cafeteria.

Now it is true that the growing diversity of our campuses is accompanied by a tendency toward fragmentation in many academic communities. There are a variety of reasons for this. Some delineation along racial, ethnic, and other lines is appropriate. It certainly is true that studies of human affairs require examination from the perspectives of the various peoples who have led or participated in them. Then, too, individuals gain a sense of identity, a sense of history, and a sense of purpose that derive in part from exploring and affirming their personal heritage. That is why it is appropriate for there to be ethnic interest groups, women's groups, and other culturally based activities on our campuses.

But there are lines that can be crossed from the productive to the counter-productive. This occurs when we move into too much self-centeredness, and when we fall victim, for example, to what Cornel West calls "racial reasoning," which creates a closing-ranks mentality stemming from fixation on racial authenticity.[1] At some point, a community ceases to be inclusive if its constituent groups all define themselves in exclusivist terms, regardless of whether they comprise a majority or minority, or whether they have come recently to the table or have been there since the inception.

The tensions introduced by diversity into the academic community are very real. So are the opportunities and responsibilities that it makes possible. We need to find ways for our differences of experience, culture, and perspective to enrich, rather than divide, our community. As Alfred North Whitehead said in his 1925 lectures on Science and the Modern World, "Other nations of different habits are not enemies: they are godsends."[2] This is true whether we speak of societies, professions, or single institutions. The electrical engineer and the mechanical engineer are able to build systems together that neither can build alone. Men and women together create a balanced discourse and world view. Black and white...brown and yellow...red and tan...create a campus and a nation far more meaningful and creative than any alone.

Speaking to this issue, Paul Penfield, the head of the Department of Electrical Engineering and Computer Science, concluded in a recent thoughtful essay that "a diverse faculty can carry out the mission of our department better than a nondiverse one." This mission, he said, includes attracting the best students, providing them the best environment for learning, and helping them to develop the necessary personal and professional skills for a fulfilling life. These goals are well served by at least three benefits of faculty diversity—providing role models, enriching the intellectual environment, and improving counseling and mentoring.[3]

Penfield's key point is that a diverse faculty can better accomplish our central mission—the tasks that we collectively consider to be our core activities. The very term "university" denotes a gathering together for common purpose, with learning as the unifying force. We are all here at MIT for the same fundamental purpose: to pursue our intellectual interests and to improve ourselves and our society through teaching, study, and research. We must be more determined to use this common focus to overcome the centrifugal forces of separatism. Through community and civility, we enhance our ability to grow as individuals. This is particularly important in times of change.

Writing of such times, Martin Luther King warned that "our very survival depends on our ability to stay awake, to adjust to new ideas, to remain vigilant and to face the challenge of change. . . . Together we must learn to live as brothers or together we will be forced to perish as fools."[4]

A DYNAMIC INTELLECTUAL MAP

Fragmentation has accompanied the changing racial and social profiles of our university communities, but fragmentation is part of our intellectual history as well. Over the past century, the exponential expansion of knowledge—coupled with the increasing complexity of society—has resulted in fields of knowledge becoming increasingly specialized and distinct from one another.

Most twentieth century science has been reductionist in nature.

PHOTO: MIT COMMUNICATIONS OFFICE/STEVE HAU

Despite the goals of discovering the great unifying principles, much of what scientists do is to refine and narrow; to burrow deeper and deeper into structure; to move from systemic description to component to cell to gene to molecule. Over time, this narrowing—together with the consequent explosion of factual knowledge—led to division and specialization. This fragmentation was codified ultimately as scientific disciplines, subdisciplines, and specialties. We became increasingly technical and less concerned with the larger issues that give rise to scientific curiosity to begin with.

The same was true—perhaps more so—of technologists. After World War II, engineers, especially in academia, began to specialize. Even systems engineering itself became more of a specialty than a unifying concept.

For a time, the humanities and social sciences followed much the same path—in part because the knowledge base was expanding, although not so dramatically, and not for the same reasons. Expansion and diversification in the humanities and social sciences came about with the inclusion of knowledge about aspects of society and human experience that had heretofore been largely neglected in academia. I refer here to non-Western cultures and civilizations, to groups that have not been economically and socially powerful, and to popular culture, for example. This, coupled with the pattern of increasing specialization in other disciplines and the lure of the powerful quantitative techniques of the sciences, tended to break down the humanities and social sciences into increasing numbers of specialties as well.

In all of these fields, specialization was a natural response. It was one way of dealing with the information explosion. But in many ways, it led to an intellectual tower of Babel.

But now there is a shifting of the tide, as scholars and researchers pay more attention to how disciplines can inform one another. Within the humanities and social sciences, for example, scholars are applying the methodologies of anthropology to social and cultural history. And in the sciences, the line between biology and chemistry is increasingly difficult to draw.

The forces calling for greater communication among fields do not stop at the boundaries of science and engineering on the one hand, or of the social sciences and humanities on the other. A greater synthesis is becoming paramount in response to many of the challenges that we face.

Perhaps the ultimate example is global environmental change. The problem of humankind's effects on the earth's atmosphere cannot be understood by physical scientists without data collected by sophisticated engineering instruments, and the meaning of the data and its projection into the future cannot be contemplated without the use of prodigious calculations carried out on state-of-the-art computers created by engineers and computer scientists. More to the point, all of this scientific knowledge is useless unless we understand the human, emotional, cultural and political responses to potential changes in the earth's climate and ecosystems. And still more to the point, if scientists discover ways in which escalating or irreversible damage to the earth is caused by human behavior, the historians and economists, political scientists and psychologists, writers and artists must be called upon to suggest ways in which that behavior can be changed.

This is but one example of how changing questions and challenges are making us increasingly aware of the interconnectedness of both things and ideas that comprise our research and that must be reflected in our teaching. Interdisciplinary research and study are hardly new. Indeed, it has been a catch phrase on campuses for about three decades, and at MIT, for even longer. A variety of approaches to academic organization have been attempted to foster such work. Centers and institutes have been formed for this purpose, and administrators have been assigned the task of promoting interdisciplinary work. Many of these efforts failed. As far as I know, none of the experiments of dissolving traditional academic departments and rearranging them along cross-disciplinary lines has been successful. Yet there is a decided recent upturn in truly interdisciplinary work. Why?

The reason is obvious: many of the really interesting and intellectually challenging issues of the day simply transcend disciplinary boundaries. Scholars need their colleagues' expertise. The sheer complexity of these problems demands it. Form is again following function. Ralph Gomory once indicated that as senior vice president for science and technology at IBM, he had tried many different ways to get researchers to work well together across disciplinary boundaries. Organization charts were redrawn, and offices and laboratories were regrouped and rearranged. Nothing really worked well. Finally, the truth that

PHOTO: MIT NEWS OFFICE/DONNA COVENEY

should have been apparent all along emerged. Researchers worked well across disciplines if they were engaged in solving a problem that interested and excited them, and that required each other's expertise. The same is even more true in academia.

This trend of coalescing of people and ideas from intellectually disparate disciplines to gain new insights and solve new problems will continue. It will be very dynamic—not a matter of creating a few new centers or institutes, but a shifting and changing scene that will require institutions like MIT to be very nimble. We must be able to reorganize and rearrange our efforts without having to continually build and dismantle bureaucratic structures, or physical ones for that matter. The idea of virtual centers is one powerful way to accomplish this, and in the last two years, four virtual centers have been established at the Institute.

Advances in information technology will soon enable us to take a quantum leap in the way we deal with issues that emerge from the continual reorganization of knowledge. Work will increasingly be done in "collaboratories," that is, through computer-mediated collaboration that transcends geographical and temporal distances. As the national and international information infrastructure expands in scale, sophistication, and ease of access, the traditional meaning of creating, archiving, disseminating, and accessing information will be lost. We will readily sift through national and international data bases to garner, combine, and shape information from an unimaginably wide variety of sources.

Thus, the complexity of important problems and areas of research and study is expanding rapidly, as is our knowledge base. Progress will depend on our ability to effectively combine knowledge and expertise of many different sorts. Specialists and in-depth, disciplinary explorations will still be needed, but the critical factor will be our ability to work together as teams and to collectively focus our disparate knowledge and expertise on problems and issues of importance.

INTEGRATIVE EDUCATION IN ENGINEERING

Our curriculum, and even our way of teaching, derives from our research and scholarly activities. Thus, we will see this trend of integration and greater interdisciplinary activity expressed in our educational programs as well. Nowhere at MIT is this more evident than in the School of Engineering.

Engineering education in the United States generally follows a format originating in the fifties and sixties. This was the period of the engineering science revolution. Stimulated by the foresight of leaders in engineering education, especially at MIT and Stanford, faculties developed curricula that brought scientific tools and approaches to bear on engineering problems. This was driven by the need to address the challenging issues presented by space flight, the development of computing, the sophisticated defense needs during the Cold War, and the rapidly evolving electronics industry. All benefited enormously from this approach, and still do. During this period there also was a rapid development of research and graduate education in American universities. Engineering faculty members increasingly built their activities and approach to research and education on the model of the physical sciences. Inevitably, engineering subjects and activities became increasingly specialized.

The results of the engineering science revolution were, and are, remarkable in terms of the increased sophistication of engineering analysis and the depth of knowledge possessed by engineering graduates. This revolution was so powerful that the basic structure of engineering curricula in this country has been unchanged for over three decades. Of course, curricula have been revised and improved, especially through the influence of computing, but the basic structure has been rather static.

The context within which engineering is practiced, however, has changed dramatically during the last decade or two. The Cold War has come to an end, bringing with it a rapid redirection of federal, industrial, and public priorities toward civilian concerns. And because of shifting geopolitics, changing economic structures, and rapid communications, many of our central concerns are of a much less isolated and national nature, and are marked more and more by interconnectedness and global perspectives.

In this changing world, many American industries have lost their positions of dominance, and have moved, sometimes grudgingly and sometimes enthusiastically, from national to international perspectives and operations in order to remain competitive. There are other changes as well. Large corporations have dispersed their functions internally and externally in new ways. More technical work is outsourced, both domestically and internationally. Emphasis has been placed on reducing product development times; improving the quality of manufactured products; integrating design, development, and process functions; and developing new management styles and methodologies. Engineering graduates are increasingly ill-adapted to this new environment, because they lack sufficient flexibility, systems perspective, understanding of manufacturing processes, team orientation, communication skills, and experience and appreciation for the broader context.

It must be said that the lack of skills needed for immediate deployment as practicing engineers has been the theme of various national reports for many decades. Yet the immediacy of this view today, in my opinion, is much greater and more accurate than in the past. The scale, complexity, and rapid time frame of much contemporary engineering is different—and will continue to increase.

Our students need more exposure to the integrative aspects of engineering design and practice—to the analysis and management of large scale, complex systems. They need more experience with, or at least appreciation of, the integration of mechanical, electronic, computational, and perhaps optical systems. They also need an increased understanding of the larger economic, social, political, and technical systems within which scientific principles and engineering analysis and synthesis operate in order to create technological change. And these must be presented as what they indeed are: difficult intellectual challenges.

So here is the paradox: we have developed an educational approach that provides students with an unsurpassed grasp of fundamentals of individual engineering and science disciplines,

which are organized as fragmented disciplines and subdisciplines. But our graduates increasingly need integrative experiences and subjects. How do we shift the balance? What is the optimum?

It is generally agreed among advisors from industry, as well as our own faculty, that a strong working knowledge of fundamentals is the most important goal of an undergraduate engineering education. This strength must be retained, as must the encouragement of flexible thinking and innovation. We cannot run the risk that ten or twenty years from now our engineers will be adept at reducing product development cycles and at manufacturing high-quality products through continuous improvement, but will have lost their edge in creativity so that the new ideas that are driving a knowledge-intensive world are generated elsewhere.

Still, we must build greater cooperative strengths in our students by increased attention to teamwork and collective enterprises. The MIT tradition of "design-build-operate" experiences obtained by many students through the 2.70 design contest and the Undergraduate Research Opportunities Program are good examples. The ideas embodied in these and other programs, such as Concourse, the Experimental Study Group, the Integrated Studies Program, the freshman advisor seminars, and the new team approach to introductory chemistry subjects can provide lessons that we can incorporate more broadly into the education of our students. If our faculty become committed to the idea of change in the undergraduate curriculum, their creativity and directed energy will ensure success.

Dramatic curricular change, however, most naturally flows from graduate programs. The Leaders for Manufacturing Program, which is jointly organized by the School of Engineering and the Sloan School of Management, in partnership with a number of US manufacturing firms, has already demonstrated a new paradigm in the education of engineer/managers. The goal of the program is to discover and translate into teaching and practice the principles that will produce world-class manufacturing and manufacturing leaders. Working together, faculty and their industrial partners have brought disparate disciplinary expertise and perspectives to the development of a curriculum of study and research organized around the themes of Foundations, Integration, and Leadership. By involving many faculty and by opening LFM subjects to other students, the program is having an ever-increasing influence on education at MIT and elsewhere.

The next few years afford us an opportunity to play an even more dramatic and effective role in promoting a more integrative approach to the education of engineers. MIT faculty, in the context of a major five-year planning exercise, are debating the merits of a number of proposals—including the establishment of a cross-School department concerned with linking technology, management, and policy. Several departments are considering restructuring their curricula to identify or create common sequences of courses that could serve multiple departments, thereby emphasizing the commonality of objectives, knowledge, and techniques across disciplines.

In addition, the Dean of Engineering, Joel Moses, has proposed

PHOTO: MIT COMMUNICATIONS OFFICE/BROOKS KRAFT

the establishment of a second professional degree to be offered through a radical new master's program in systems engineering/systems architecture. This is an idea whose time has come. The program, which would span the Engineering and Sloan Schools, would address the needs of first-rate engineers who have been in practice for five to ten years, and who demonstrate the talent to become systems engineers and architects in their fields and/or to move toward positions such as vice president of engineering. The program would be based on a combination of campus and industry experiences that would develop and teach approaches to the engineering of large-scale, complex systems, including those that require considerable public policy implications. Just as with the Leaders for Manufacturing Program, the philosophy, insights, and approaches developed in such a program would soon influence the entire engineering curriculum.

The move toward greater emphasis on common fundamentals and a more holistic approach to engineering education is apparent at the national level as well. A number of engineering deans and university presidents who are engineers have joined with colleagues from industry to work together with the Accreditation Board on Engineering and Technology (ABET) to establish a far more flexible approach to accreditation—one that measures outcomes against principles instead of counting credits for discrete elements in the curriculum. This cooperative effort recognizes that engineering schools need the flexibility to develop curricula appropriate to the times.

And these times call for a more integrative experience for engineering students. By returning closer to the roots of engineering practice, armed with the knowledge and sophisticated approaches of engineering science, but with an eye on the nimbleness and flexibility required by a future of rapid change, we can best prepare our students to lead through engineering.

A CLOSING WORD

The intellectual and social map of MIT, and the world in which MIT operates, is marked by increasing diversification. These changes are the cause of discomfort and tension. They are also the source of renewal and growth.

We should welcome these changes and the opportunities they bring. And we should rise to the challenge they present: to recognize the importance of our varied talents and backgrounds while renewing a sense of common vision and purpose. We need to value, celebrate, and build on our differences, but also to rediscover and renew our mutual commitment to the shared values of academia. We must have community. We must have mutual respect. We must have common purpose.

It is a time to come together, to rediscover unifying forces, and to integrate our energies to solve grand problems.

Charles M. Vest
October 1993

PHOTO: MIT COMMUNICATIONS OFFICE/STEVE HAU

IN SPECIAL RECOGNITION

This year saw a number of changes within the faculty and staff of MIT.

Professor Lester C. Thurow announced his decision to step down from his post as Dean of the Sloan School of Management. Dean Thurow will return to his research and teaching at the Sloan faculty after taking a sabbatical. Under Professor Thurow's leadership, the Sloan School developed extensive international activities consistent with the globalization of business, expanded and increased the diversity of the faculty, and forged important programmatic links with the School of Engineering. Dean Thurow was extraordinarily effective in his communications to business and policy leaders and the broader public. He led the School to reconceptualize much of management education for the decades ahead.

New department or academic program heads announced during the past year were: Stanley Fischer, Head of the Economics Department; Robert G. Griffin, Director, Francis Bitter National Magnet Laboratory; John V. Guttag, Associate Head, Department of Electrical Engineering and Computer Science; and William C. Hanson, Industry Codirector, Leaders for Manufacturing Program.

Among key changes in the administration during the past year were the appointments of Victoria V. Sirianni as Director of Physical Plant and Richard A. Hill as Director of Athletics. Also announced were the promotion of Doreen Morris to Assistant Provost for Administration and the promotion of John T. Preston to Director of Technology Development.

The honors and achievements of MIT faculty and staff are so numerous that, in this part of the report, I mention only some of the individual efforts and awards which have brought such distinction to the Institute.

Dr. Frank Press, former Institute Professor, has been named as one of two winners of the prestigious 1993 Japan Prize for his pioneering work in geophysics. Likened to Nobel Prizes, the Japan Prizes recognize contributions to human progress. Dr. Press was honored in the category of Safety Engineering and Disaster Mitigation for his original work using the surface wave motion and ruptures of the earth's crust and upper mantle as predictors of earthquakes.

J. David Litster, professor of physics and Vice President and Dean for Research, was awarded the 1993 Irving Langmuir Prize in Chemical Physics by The American Physical Society. The Langmuir Prize recognizes outstanding interdisciplinary research in chemistry and physics. Professor Litster was cited for his pioneering experimental and theoretical studies of phase transitions in liquid crystals.

The National Academy of Sciences (NAS) presented its highest honor to former MIT president, Institute Professor Jerome B. Wiesner, in award ceremonies held in Washington, DC, on April 26, 1993. Dr. Wiesner received the academy's Public Welfare Medal for his devoted and successful efforts in science policy, education, and nuclear disarmament and world peace.

NAS also honored three other MIT faculty. Dr. Peter S. Kim, associate professor of biology, assistant investigator with the Howard Hughes Medical Institute, and member of the Whitehead Institute for Biomedical Research, received the Award in Molecular Biology. Dr. Steven Pinker, professor of psychology in the Department of Brain and Cognitive Sciences and codirector of the Center for Cognitive Sciences, received the Troland Research Award for research in experimental psychology. Dr. Boris Magasanik, Jacques Monod Professor of Microbiology, Emeritus, and senior lecturer in the Department of Biology, received the Selman A. Waksman Award in Microbiology.

The academy recently inaugurated the Rosenblith lectures, an international lecture series on global science and technology issues, in honor of Dr. Walter A. Rosenblith, Institute Professor Emeritus, former MIT Provost and former foreign secretary of the NAS. The lectures recognize Dr. Rosenblith's many contributions to international scientific cooperation. The biennial series will be presented alternately by distinguished US and foreign scientists chosen to reflect his international concerns.

Dr. Richard C. Mulligan, professor of biology and member of the Whitehead Institute, was named as the first recipient of a new award given by The American Society for Biochemistry and Molecular Biology. The ASBMB-Amgen Award recognizes "significant achievement in the application of biochemistry and molecular biology to the understanding of disease." Dr. Mulligan is a leader in the development of new technologies for transferring genes into mammalian cells.

Professor of Music John H. Harbison was elected into the American Academy and Institute of Arts and Letters in 1992. In announcing Professor Harbison's election, composer George Perle described his work as "music in which complexity of detail and structure and a contemporary harmonic language do not stand opposed to immediacy of feeling and accessibility."

Three faculty members were elected as Fellows of the American Academy of Arts and Sciences: Dr. Julius Rebek Jr., Camille Dreyfus Professor of Chemistry; Dr. Ronald L. Rivest, Edwin S. Webster Professor of Electrical Engineering and Computer Science; and Dr. Carl O. Pabo, Professor of Biophysics and Structural Biology and Howard Hughes Medical Institute Investigator. Their election brings to 212 the number of active and emeriti/ae faculty members who are Academy Fellows. Seven MIT alumni/ae were also elected.

Three faculty members were elected to the National Academy of Engineering: Dr. Charles M. Vest, President of MIT; Dr. Alexander M. Klibanov, professor of chemistry; and Dr. Richard C. Larson, professor of electrical engineering and codirector of the Operations Research Center. Their election brings to 96 the number of MIT active and emeriti/ae faculty elected to NAE. Eleven MIT alumni/ae were also elected to the Academy this year.

Four faculty members were elected to the National Academy of Sciences: Dr. Klaus Biemann, professor of chemistry, Dr. Claude R. Canizares, professor of physics and Director of the Center for

Space Research, Dr. Stephen H. Crandall, professor emeritus of mechanical engineering and senior lecturer, and Dr. Mario J. Molina, professor of atmospheric chemistry and chemistry. Their election increases the NAS membership of MIT faculty to 96. Seven MIT alumni/ae were also elected.

Two faculty members were elected into the Institute of Medicine: Dr. Stephen J. Lippard, Arthur Amos Noyes Professor of Chemistry; and Dr. Vernon R. Young, Professor of Nutritional Biochemistry. Four alumni/ae were also elected to the Institute.

Four faculty members were elected to the rank of Fellow in the American Association for the Advancement of Science: Dr. Jerome I. Friedman, Institute Professor and professor of physics; Dr. Lionel C. Kimerling, Thomas Lord Professor of Materials Science and Engineering; Dr. Richard S. Lindzen, Alfred P. Sloan Professor of Meteorology; and Dr. J. David Litster, professor of physics and Vice President and Dean for Research.

In December 1992, as Thomas E. Shepherd Jr. retired after 25 years of service in the MIT Physical Plant—most recently as associate director—he became the first recipient of the MIT Trustees Award. This new award will be given from time to time to a member of the MIT community who has demonstrated "uncommon leadership in the fulfillment of MIT's mission in education, research and public service." In presenting the award, President Vest described Mr. Shepherd as "an engineer extraordinaire, a true gentleman, and a highly effective and respected member of the Institute community."

The teaching excellence of six professors and their "exemplary and sustained contributions" to undergraduate education have been recognized by MIT with their appointments as MacVicar Faculty Fellows. They are: Professor Thomas J. Allen Jr., of the Sloan School of Management; Professor Monty Krieger of the Department of Biology; Professor Charles Stewart III of the Department of Political Science; Professor Irene Tayler of the Department of Humanities, Literature Section; Professor August F. Witt of the Department of Materials Science and Engineering; and Professor James H. Williams Jr. of the Department of Mechanical Engineering. The MacVicar Faculty Fellows Program was established in 1991 following the death of Margaret L. A. MacVicar, MIT's first dean of undergraduate education, and honors her untiring efforts to enhance undergraduate education.

Professor Phillip A. Sharp, internationally recognized for his contributions to molecular biology, was selected as the 1993–94 recipient of the James R. Killian Jr. Faculty Achievement Award, which recognizes extraordinary professional accomplishments and service to MIT. The selection committee's citation described Dr. Sharp as "one of the giants of modern molecular biology."

Dr. Jesús A. del Alamo, associate professor in the Department of Electrical Engineering and Computer Science, was named the 1993 recipient of the Harold E. Edgerton Faculty Achievement Award, given annually to a junior faculty member in recognition of exceptional teaching, research, and scholarship. Professor del Alamo has made significant contributions to advancing the understanding of compound semiconductor devices. The selection committee praised his "modernization of the design project in the electrical engineering core subject on electronic devices."

The Institute was saddened this year by the deaths of several longtime friends and colleagues.

PROFESSOR HOWARD R. BARTLETT, former head of the Department of Humanities, died in December 1992, at the age of 91. Professor Bartlett, who began teaching at the Institute in 1929, played a key role in the development of the humanities curriculum at MIT during his 38 years on the faculty. In 1958 Professor Bartlett and his late wife, Helen, took up residence in Burton House, as the first step in the development of the Institute's housemaster system.

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PROFESSOR EMERITUS ROBERT L. COBLE died in August 1992, at the age of 64. He came to MIT in 1960 as an assistant professor in the Department of Metallurgy, now the Department of Materials Science and Engineering, and retired in 1988. Professor Coble was widely known for his research on physical ceramics and the kinetics of ceramics processes.

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J. HARVEY EVANS, professor emeritus of naval architecture, died in November 1992, at the age of 78. Professor Evans, who joined the MIT faculty in 1947, was a specialist in ship structure, computer-aided design of marine vessels, and the structure of vehicles designed to operate at great depths. He retired in 1978, but continued to work in his profession.

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PROFESSOR BERNARD T. FELD, an emeritus professor of physics, died in February 1993, at the age of 73. He began teaching physics at MIT in 1946 and retired in 1990. Dr. Feld contributed to the development of the atom bomb and later became a leading voice for arms control and nuclear disarmament. His research at MIT focused on experimental and theoretical research in high-energy physics.

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PROFESSOR ANN FETTER FRIEDLAENDER, a gifted economist and teacher, died of cancer in October 1992, at the age of 54. She came to MIT in 1972. She held dual appointments as the Class of 1941 Professor of Civil Engineering and Economics and served as the head of the Economics Department from 1983 to 1984, prior to serving as Dean of the School of Humanities and Social Science from 1984 to 1990. She was the first woman to serve as a department head, and the first to serve as an academic dean at MIT. Professor Friedlaender was an authority in the field of public finance, with a specialty in transportation studies. She played a leading role in bringing about curriculum changes that strengthened the Institute's humanities, arts, and social sciences core requirement for

graduation while also establishing a minor in those areas. She helped to establish the Program in the History and Social Study of Science and Technology leading to the Ph.D., and was a major force in introducing the Writing Requirement at MIT.

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DR. TRUMAN S. GRAY, professor emeritus of engineering electronics, died in November 1992, at the age of 86. Professor Gray began his career at MIT in 1927 as a research assistant in electrical engineering and joined the faculty in 1935. He retired in 1971, but continued his teaching in the department. Professor Gray was a pioneer in the field of electronic instrumentation, measurement and control, and was responsible for the design and development of the initial reactor instrumentation at Brookhaven National Laboratory.

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DR. EVERETT E. HAGEN, professor emeritus of political science and economics, died in November 1992, at the age of 86. He came to MIT in 1953 as senior staff member in the Center for International Studies and visiting professor of economics. He was appointed professor in 1965, became the Director of the Center for International Studies in 1970, and retired in 1972. His specialty was the economic and social development of emerging nations.

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ROBERT O. PREUSSER, professor emeritus of visual design in the School of Architecture and Planning, died in November 1992, at the age of 73. A one-year appointment in 1954 led to a 31-year teaching career at the Institute. From 1974 until retirement in 1985, Professor Preusser was director of education at MIT's Center for Advanced Visual Studies. He developed the first studio course at MIT for non-artists, encouraging students to use their scientific and technological studies to create two- and three-dimensional visual forms.

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DR. ROBERT R. SHROCK, professor emeritus of geology, died in June 1993, at the age of 88. He began his 38-year career at MIT in 1937, serving as head of the Department of Geology and Geophysics from 1949 to 1965, and initiating MIT's joint program with the Woods Hole Oceanographic Institution. Professor Shrock was an internationally known authority on paleontology, sedimentary rocks, and stratigraphy. He was noted for his work indexing fossils, and the fossil of a squid-like invertebrate, *Kentlandoceras Shrocki*, was named after him.

❧

CYRIL STANLEY SMITH, Institute Professor Emeritus, died in August 1992, at the age of 88. He taught at MIT from 1961 until his retirement in 1969. Professor Smith was a world-renowned physical metallurgist and historian of metallurgy. He was recognized as an authority on the historical relationships between people and the materials they came to understand and use.

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PROFESSOR PHYLLIS A. WALLACE, professor emeritus of management at the Sloan School, died in January 1993, at the age of 69. In 1975, Dr. Wallace became the first woman to hold the rank of full professor at the Sloan School. A well known labor economist who pioneered the study of sexual and racial discrimination in the workplace, she spearheaded, through her scholarship, a precedent-setting legal decision in a federal case concerning sex and race discrimination in American industry.

STATISTICS FOR THE YEAR

REGISTRATION

In 1992–93 student enrollment was 9,798, compared with 9,541 in 1991–92. There were 4,520 undergraduates (4,325 the previous year) and 5,278 graduate students (5,216 the previous year). The international student population was 2,170, representing 9 percent of the undergraduate and 34 percent of the graduate populations. These students were citizens of 97 countries. (Students with permanent residence status are included with US citizens.)

In 1992–93 there were 2,722 women students (1,506 undergraduate and 1,216 graduate) at the Institute, compared with 2,589 (1,433 undergraduate and 1,156 graduate) in 1991–92. In September 1992, 403 first-year women entered MIT, representing 35 percent of the freshman class of 1,147 students.

In 1992–93 there were, as self-reported by students, 2,271 minority students (1,806 undergraduate and 465 graduate) at the Institute, compared with 2,052 (1,643 undergraduate and 409 graduate) in 1991–92. Minority students included 343 African Americans (non-Hispanic), 43 Native Americans, 453 Hispanic Americans, and 1,432 Asian Americans. The first-year class entering in September 1992 included 508 minority students, representing 44 percent of the class.

DEGREES AWARDED

Degrees awarded by the Institute in 1992–93 included 1,100 bachelor's degrees, 1,161 master's degrees, 35 engineer's degrees, and 516 doctoral degrees a total of 2,812 (compared with 2,721 in 1991–92).

STUDENT FINANCIAL AID

During the academic year 1992–93, the financial aid program reflected both increased need and an increased number of

needy undergraduate students. A total of 2,652 students who demonstrated need for assistance (59 percent of the enrollment) received $31,879,000 in grant aid and $10,669,000 in student loans from all sources. The total, $42,548,000, represents a 10 percent increase in aid compared to last year.

Grant assistance to undergraduates was provided by $9,080,000 in income from the scholarship endowment, by $984,000 in current gifts, by $3,144,000 in federal grants (including ROTC scholarships), and by $2,751,000 in direct grants from non-federal outside sources to needy students. In addition, $15,920,000 in scholarships from MIT's unrestricted funds was provided to undergraduates, inclusive of the special program of scholarship aid to needy minority group students which represented $408,000, and the MIT Opportunity Awards which accounted for $885,000. An additional 442 students received grants irrespective of need from outside agencies, totaling $2,248,000. The undergraduate scholarship endowment was increased by the addition of $6,109,000 in new funds. These new contributions increased the endowment for scholarships by 8 percent to $82,038,000.

Loans totaling $10,914,000 were made to undergraduates, a 13 percent increase from last year. Of this amount, $1,329,000 came from the Technology Loan Fund, $3,636,000 came from the Federal Perkins Loan Program, and $5,949,000 came from the state-administered Stafford Guaranteed Student Loan Program and other outside sources.

Graduate students obtained $2,971,000 from the Technology Loan Fund. In addition, $330,000 was loaned by MIT under the Federal Stafford Guaranteed Student Loan Program. The total, $3,301,000, represents a 3 percent decrease from last year's level. Graduate students obtained $4,428,000 from outside sources under the Federal Stafford Program, 15 percent more than last year, and $982,000 from Federal Supplemental Student Loans. Graduate students also received $72,000 in Perkins Loan funds.

The total of loans made to undergraduate and graduate students was $19,697,000, a 6 percent increase over last year.

The continuing sluggishness of the economy was reflected in the increased number of needy students and the increased average need among this population. The number of needy students increased by 7 percent over the previous year, and the average need per student increased by 5 percent to $17,679. In the aggregate, the financial aid program required the families of needy students to contribute $22,508,000, and MIT provided $47,150,000 in aid dollars including work programs. As in past years, the aid program provided two-thirds of needy students' total costs.

CAREER SERVICES AND PREPROFESSIONAL ADVISING

With the economy continuing in the doldrums, there was reason to worry at the beginning of the year where graduating students would find a market for their talents. As it turned out, recruiting activity held to the same level as in 1991 and 1992, but with a shift in the industries represented. Forty percent of the 377 employers who came recruiting were software houses, information systems consulting firms, financial institutions, or

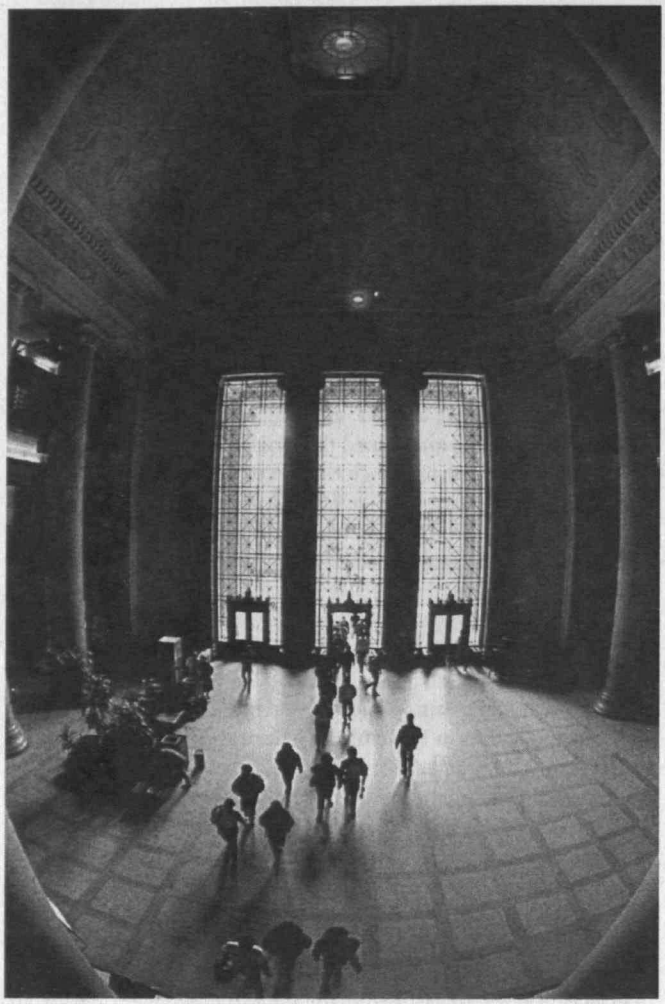


PHOTO: MIT COMMUNICATIONS OFFICE/STEVE HAU

business consulting firms. Ten years ago, such firms made up little more than 15 percent of the traffic.

The strongest demand was for computer skills, however learned. Most MIT students are versatile users of computers by the time they graduate. Placement data are not yet available, but it is likely that many students who were discouraged by the job outlook in their major field fell back on their computer skills in looking for interesting work. Few students at the bachelor's and master's level have come to the office since the academic year ended still looking for employment. The situation has been more difficult for Ph.D.s. They, like other students, have been turning to opportunities outside their field, including opportunities in finance and consulting.

Salaries in most fields have changed little from a year ago. About the only students enjoying significant gains were those with bachelor's and master's degrees in computer science (with offers up more than 8 and 5 percent respectively, to $39,000 and $45,360), and those with bachelor's degrees in electrical engineering (up over 5 percent to $38,400), and in management science (up nearly 6 percent to $37,000).

The number of MIT applicants to medical school continued to increase. Preliminary data show 143 undergraduate, graduate, and alumni/ae candidates, compared with 131 at the same time in 1992 and 119 in 1991.

GIFTS

Gifts, grants, and bequests to MIT from private donors in 1992–93 totaled $96.8 million. This amount includes cash, securities, and real estate gifts totaling $89.2 million and $7.6 in support through the Industrial Liaison Program. In addition, gifts in kind, mostly of equipment, totaled $5.0 million. The gifts reported by the Alumni Fund were $18.9 million.

In the post-campaign period following the conclusion of the successful *Campaign for the future*, payments on pledges and significant new commitments continue to be received. Major efforts are continuing to increase endowment for student financial aid, faculty support, academic initiatives, new and renovated space, and unrestricted funds.

FINANCES

As reported by the Vice President for Financial Operations and the Treasurer, the total financial operations of the Institute, including sponsored research, amounted to $1.13 billion—an increase of 4.7 percent from 1991–92. Education and general expenses—excluding the direct expenses of departmental and interdepartmental research and the Lincoln Laboratory—amounted to $542.1 million during 1992–93 compared with $509.7 million in 1991–92. The direct expenses of departmental and interdepartmental sponsored research on campus increased from $231.5 million to $259.2 million, while direct expenses of the Lincoln Laboratory's sponsored research decreased from $342.1 million to $332.6 million. Current revenues used to meet the Institute's operating expenses totaled $1.12 billion, augmented by $5.3 million in current gifts, $7.0 million of other fund balances, and $3.1 million of funds functioning as endowment.

At the end of the 1993 fiscal year, the Institute's investments, excluding retirement funds, student notes receivable, and amounts due from educational plant, had a book value of $1.6 billion and a market value of $2.13 billion compared to last year's book value of $1.5 billion and market value of $1.95 billion.

PHYSICAL PLANT AND CAMPUS ENVIRONMENT

Safety concerns for those who work, study, and reside on the MIT campus were heightened as a result of the tragic stabbing death of an MIT student on Memorial Drive soon after the start of the school year. The exterior emergency telephone system was upgraded, exterior lighting was improved in certain areas, personal safety programs were augmented, and the Institute's safety shuttle service, Safe Ride, was improved with the addition of two new vans. In addition, MIT and Cambridge Police now jointly patrol the perimeter of the campus periodically, several days a week, in order to provide high visibility and help deter campus crime.

After an extraordinary series of negotiations, agreement was reached with the City of Cambridge for the leasing of MIT land on Albany Street to the City for the construction of a new home for the Cambridge and Somerville Program for Alcoholism and Drug Abuse Rehabilitation (CASPAR) in exchange for the transfer of the West Campus portion of Amherst Street to MIT and for easements granted to MIT to facilitate long-term development of Vassar Street, west of Massachusetts Avenue, and the East Campus areas around Carleton and Hayward Streets. In addition, an agreement with the City and the Cambridgeport neighborhood on the rezoning of the northwest campus area was concluded this year. These actions now enable the Institute to complete related planning for much-needed graduate student, faculty, and staff housing in this area.

During the year, many renovations and physical improvements were undertaken across the campus. Of particular significance were major renovations to the kitchen and serving areas at Walker Memorial; reconstruction of Room 1-390, the new Bechtel Lecture Hall; the refacing of Building E38, which is located in Kendall Square; and conversion of buildings at 185 Albany Street and 350 Brookline Street for occupancy by the Plasma Fusion Center and the Office of Laboratory Supplies respectively.

Progress continued on the Biology Building with completion expected next spring. The related pedestrian and service tunnel under Ames Street was approved by the City and construction is underway. In addition, final approval was received for the construction of a 22-megawatt cogeneration facility and the initial phases of construction and the purchasing of equipment have begun.

Conservation efforts continued throughout the year on both a large and small scale. Work on the Green Lights electricity conservation program continued and, to date, lighting systems have been upgraded, utilizing more energy-efficient units, in 58 buildings. A recycling program was introduced at the Faculty Club. In this program, all paper, plastic, glass, and metal are separated for recycling. This is the first food service site on campus to do full-scale recycling and this program will serve as a test site for all other food service locations on campus.

REFERENCES

References used in the president's essay: 1) *Race Matters*, Cornel West, Beacon Press, Boston, 1993, Chapter 2; 2) *Science and the Modern World*, "Requisites for Social Progress," Alfred North Whitehead, The MacMillan Company, 1925, p. 185; 3) Memorandum on Faculty Diversity, February 26, 1993, Paul Penfield Jr., sent to the faculty of the Department on Electrical Engineering and Computer Science and other colleagues at MIT; 4) *Where Do We Go From Here: Chaos or Community?*, Martin Luther King Jr., Beacon Press, Boston, 1967, p. 171.

MIT LIFE INCOME FUNDS

MR. AND MRS. EDGAR P. EATON, JR.

HOME: Convent Station, New Jersey

CAREER: His MIT career interrupted by wartime service in the U.S. Army, Mr. Eaton earned his bachelor's degree in mechanical engineering in 1944 and took a job at the Electric Boat Company in Boston. At the end of the war, he went to work for Allis-Chalmers Company and served on special assignment building a synchrotron at Brookhaven National Laboratory.

In 1949, he joined the Carbone Corporation, designer and manufacturer of technical materials and products, in Boonton, New Jersey, and by 1957 had risen to the position of president. He became president of its parent corporation, Carbone-Lorraine Industries, in 1975 and chairman in 1989. In 1991, he founded Brinton Eaton Associates, a financial planning company in Morristown, of which he is now vice president. Long active in MIT affairs, Mr. Eaton has served in all of MIT's fundraising campaigns since the 1970s and on his class reunion gift committees. He was awarded the Bronze Beaver in 1992, and is president of the Class of 1944 as it celebrates its 50th reunion year.

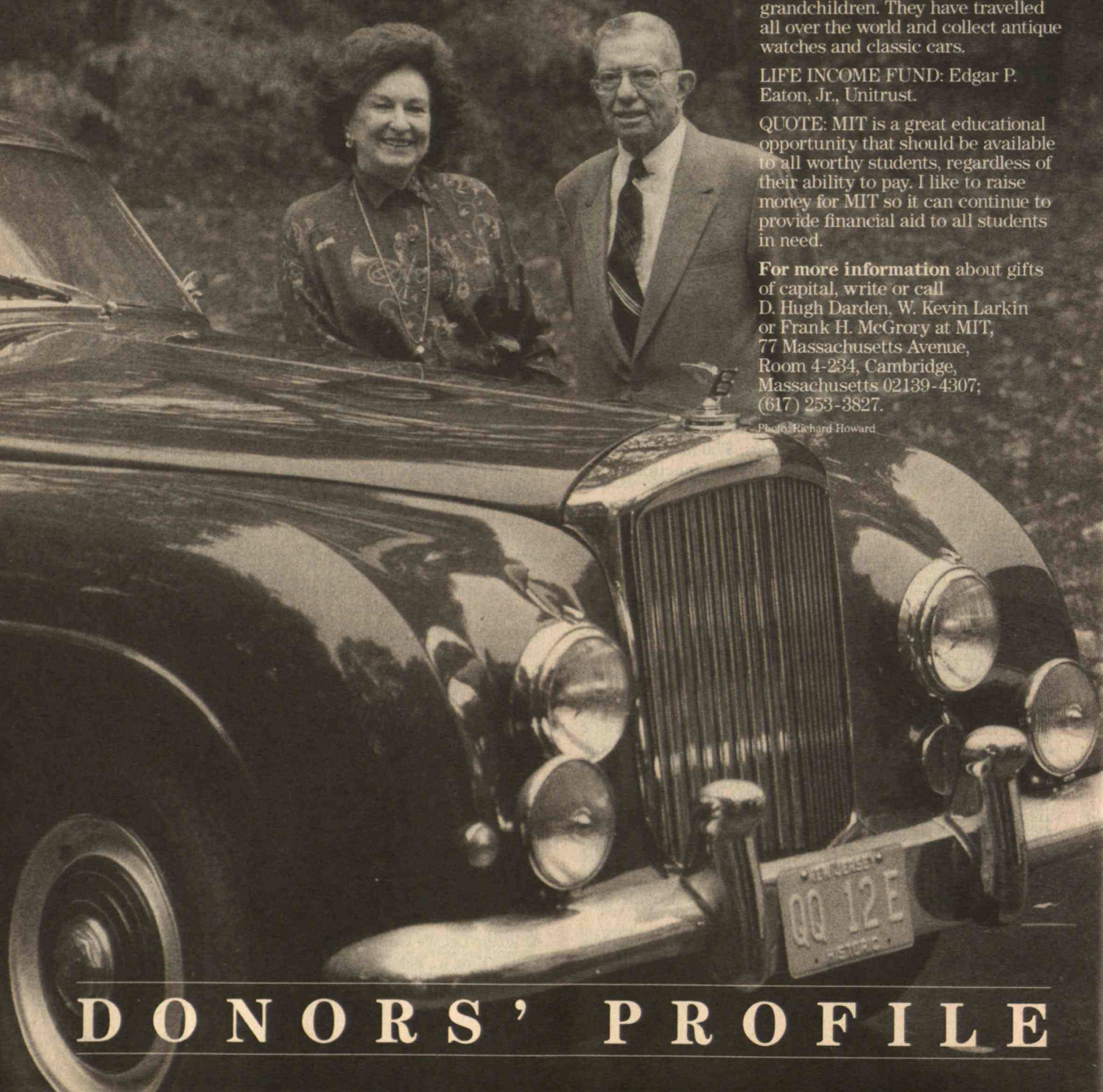
Mr. and Mrs. Eaton's family includes their two children, two children Mrs. Eaton took under her care when their parents died, and five grandchildren. They have travelled all over the world and collect antique watches and classic cars.

LIFE INCOME FUND: Edgar P. Eaton, Jr., Unitrust.

QUOTE: MIT is a great educational opportunity that should be available to all worthy students, regardless of their ability to pay. I like to raise money for MIT so it can continue to provide financial aid to all students in need.

For more information about gifts of capital, write or call D. Hugh Darden, W. Kevin Larkin or Frank H. McGrory at MIT, 77 Massachusetts Avenue, Room 4-234, Cambridge, Massachusetts 02139-4307; (617) 253-3827.

Photo: Richard Howard



DONORS' PROFILE

Toward Remedying the Organ Shortage

By Susan Reed

In the summer of 1991, Gilbert H. Mudge, Jr., cardiologist and medical director of the heart transplant program at Brigham and Women's Hospital in Boston, recalled a patient who had recently died while waiting for a heart transplant. "He was 32 and left a wife and two young children," Mudge brooded. "It was a tragedy. Here we have a therapy that works, that can return people to productive lives, but people are dying because we just don't have enough organs to go around." Two years later, Mudge struggles to remember the patient he had mourned. "I'm afraid I'm jaded," he finally says. "There have been so many since then." His lapse in memory, and apparent frustration, are understandable. Roughly 20 percent of patients waiting for heart transplants at Brigham and Women's perish before a donor heart can be found. The Partnership for Organ Donation, a Boston-based organization created in 1990 to help solve the organ shortage, reports that the bigger picture is even worse:

Illustrations by Valerie Spain

Now that organ transplants have moved out of the headlines and into standard medical practice, the problem is a lack of donors.

nearly one-third of patients awaiting hearts nationwide will die before a suitable one is located.

Organ transplantation is a victim of its own success. Once a heroic procedure, during the last decade it has become accepted therapy for a variety of end-stage diseases. Today the United States has more than 270 transplant centers and nearly 70 loosely confederated organ procurement organizations, which coordinate the distribution of organs. More than 16,000 transplants were performed in this country in 1992. Yet seven people a day are now dying while waiting for one. "The arithmetic is very simple," Mudge says. "The list keeps growing, and the donor supply hasn't substantially changed."

ROUGHLY TWO-THIRDS OF POTENTIAL ORGAN DONORS ARE LOST—OFTEN BECAUSE THE FAMILY REFUSES CONSENT OR IS NEVER ASKED.

Indeed, between 1988 and 1992 the waiting list for organs skyrocketed 86 percent, from 16,034 to 29,519, while the number of organ donors rose only 11 percent, from 4,085 to 4,521 (between 1991 and 1992 there was even a slight drop in donors, down from 4,532). The United Network for Organ Sharing, an organization based in Richmond, Va., that aims to administer an equitable organ-allocation system nationwide, notes that more than 31,000 people were waiting for organs in July of 1993, as the supply remained flat. A survey commissioned by the organization—the National Cooperative Transplantation Study—reports that in 1990, 83,028 people either died or were maintained on less-than-optimal therapies in the absence of a transplant.

The dilemma has spawned an array of potential solutions—from new ways of recruiting donors to methods for actually growing organs in the lab. And although none of these is a panacea, together they offer considerable hope.

Supply/Demand Mismatch

The first successful kidney transplant was performed in 1954 at Peter Bent Brigham Hospital by a surgical team led by Joseph Murray, who shared the 1990 Nobel Prize in medicine for his contributions to the field of organ transplantation. That transplant, between identical twins, sidestepped the problem of organ rejection: because the two shared the same genes, there was no danger that the recipient's immune system would turn against the donated kidney as foreign tissue. It was not until 1962, using a new immunosuppressive drug called azathioprine, that Murray performed the first successful transplant of a cadaveric kidney from an unrelated donor.

Following on the heels of this work, the first liver and heart transplants were performed in the 1960s. As the hurdles of organ viability and acute rejection—that is, rejection of the donor organ within the first several months—were largely overcome, chronic rejection, which occurs one or more years after the operation, remained a problem, and survival rates hovered around 50 percent.

The transplantation landscape altered radically in 1983 with the Federal Drug Administration's approval of a powerful new immunosuppressant, cyclosporine, which is now the standard medication for transplant patients. Its effectiveness, combined with strides in medical management, particularly improvements in the early detection and treatment of organ rejection and infection, have prolonged lives dramatically. While results vary by hospital, a 1992 study by the Department of Health and Human Services found that one-year survival rates were 92.9 percent for kidney transplants, 88.7 percent for pancreas transplants, 82.1 percent for heart transplants, 74.4 percent for liver transplants, 53.9 percent for lung transplants, and 53.3 percent for heart and lung transplants. And patients are not only living but living well. "Ninety percent of our heart transplant patients who survive return to their families, return to their work, return to a normal existence," says Mudge.

The harsh consequences of this success are a soaring waiting list for donor organs even while experts revise downward their estimates of the potential donor pool. Although the exact size of that pool is a matter of debate, estimates of a decade ago, which suggested as many as 29,000 donors annually, are clearly unrealistic. Lifesaving measures like seat belt laws as well as the HIV epidemic—infected organs are unsuitable for transplantation—have contributed to a smaller donor pool. The National Cooperative Transplantation Study recently estimated the potential supply of organ donors

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to be between 6,900 and 10,700 annually. The Partnership for Organ Donation's estimates are somewhat higher: between 12,000 and 15,000.

There is uniform agreement, however, that many potential donors are not tapped. While organ procurement efforts in the United States vary considerably by both state and organ procurement organization (OPO), the National Cooperative Transplantation Study has found that overall they are "only between 37 and 58 percent efficient, depending upon the criteria used for donor acceptability." The assessment of the Partnership for Organ Donation is even grimmer. "We estimate that roughly a third of all potential donors become donors," says spokesperson Jessica Drachman. She goes on to say that in roughly a third of the cases the family denies consent, and that the rest of the potential donors are lost because the family simply isn't asked or brain death—the condition under which most organs are now harvested—is never declared.

For these reasons, the Partnership for Organ Donation devotes 95 percent of its work to professional education. One aspect of this effort entails working with OPOs to concentrate on the relatively few hospitals—as little as 6 percent—that yield a full 75 percent of potential donors. Typically these are trauma centers, large community hospitals, and university medical centers: places that "see the more complicated and challenging medical and surgical cases," says the partnership's managing director Carol Beasley. That is, places where mortality is high. To help such hospitals better identify potential donors, the partnership provides key staff with current criteria for donor eligibility.

Once a potential donor is identified, the method used to approach the family becomes critical. After brain death, organs can be kept functioning for an hour or more, allowing a family time to grasp their loss before being approached about donation. Yet a survey of neurosurgeons reveals that 87 percent of all requests are made before or at the same time that the diagnosis of brain death is explained to the family. Working with four OPOs in a pilot project, the partnership has found that communicating a patient's grave prognosis early, telling the family about the patient's brain death well before making the request for organ donation, and making the request in a suitable, private setting greatly increase the likelihood of securing consent.

As a result of these efforts, donations in the four sites rose from 268 to 303. The organization is now exploring ways to extend the principles developed in the pilot project to OPOs nationwide.

Addressing Public Concerns

But professionals aren't the only ones who need to be educated; the public does, too. A recent Gallup survey commissioned by the partnership reveals that while 69 percent of Americans are willing to donate

their organs when they die, half have failed to take the one step most likely to make it happen—telling someone in their family. This oversight may stem partly from a misunderstanding of how to become a donor: nearly 80 percent of those polled believe signing a donor card is all that is necessary, when in fact hospitals will not proceed without a family's permission.

Among those most determined to set people straight is James Wolfe, associate dean of medical education at Northwestern University Medical School, former head of Northwestern's transplant program, and current president of the Coalition on Donation, a national Chicago-based organization he founded to promote the public's acceptance of organ donation as "a fundamental human responsibility." If Wolfe has his way, the public will eventually embrace organ donation in the same way it has come to perceive the wisdom of wearing seat belts and not smoking. As a result of his work, the Ad Council recently accepted organ donation as one of the two new public-interest campaigns it will promote beginning in January 1994. This campaign will be more directive than educational efforts of the past, which have generally tiptoed around the need for people to contemplate their own death. "Our approach will be 'now that you know all this, make a decision and tell somebody about it,'" Wolfe says.

Many experts say that any effective public education campaign must also dispel public distrust about the way organs are obtained and allocated—a distrust reflected in popular culture. For instance, several night-time television shows, inspired by false but rapidly spreading rumors of organ-snatching, have featured characters that wake up in terrible pain to discover one of their kidneys has been stolen.

In the opinion of several observers, some of the proposed approaches to increasing the number of donors will only further public distrust—for example, "presumed consent" bills, which legislators in states like Pennsylvania and Maryland are now considering. Under the Pennsylvania bill, the state would assume that people want to donate their organs unless they have obtained a nondonor card, checked off a box against organ donation on their state income tax return, or had a nondonor sticker placed on their driver's license. Family members could also veto donation.

"The concept of making people make a decision is sound, but I think the approach is flawed," says Kevin Sparkman, community relations manager for the Delaware Valley Transplant Program, an OPO that services eastern Pennsylvania, southern New Jersey, and Delaware. "It places too much emphasis on setting up a system for saying no." To advocates of presumed con-

sent who cite its success in Europe, particularly Austria, Sparkman and others reply that it's a mistake to extrapolate from the European experience. "We're a multicultural society," Sparkman says. "Many of our people aren't comfortable with the government saying that when you die, you're going to be an organ donor."

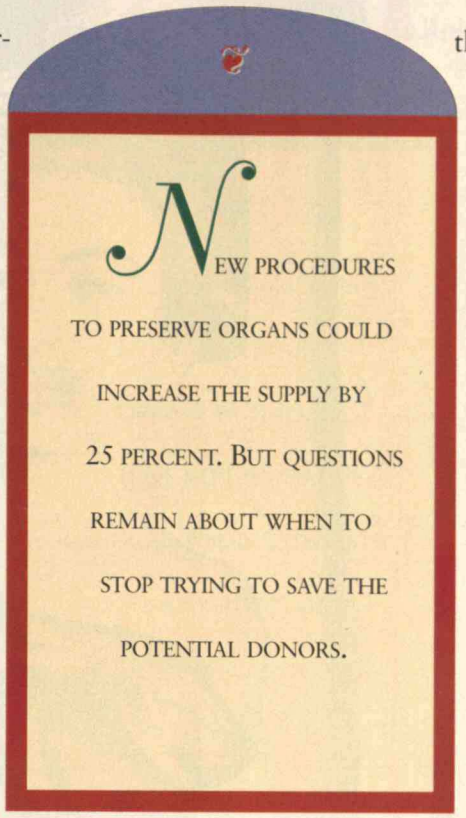
Presumed consent has also drawn the ire of ethicists. "Currently we can give our body as a gift and that is a positive choice," said Andrew Kimbrell, policy director of the Foundation on Economic Trends, a watchdog group on bioethics issues, in a December 1992 article in the *Boston Globe*. "But with something as intimate and with as many religious and ethical implications as the human body, we don't want the state to make that decision."

Paying families for their loved ones' organs is another controversial proposal. Supporting the idea in an article that appeared in *Journal of the American Medical Association* in 1991, Thomas G. Peters, a surgeon at the Jacksonville Transplant Center, argued, "Our concerns must focus not on some philosophic imperative such as altruism, but on our collective responsibility for maximizing lifesaving organ recovery." Peters suggested a standard payment of "$1,000, paid only through the controlled organ acquisition process as a death benefit to the consenting next-of-kin."

More recently, a report of the Council on Ethical and Judicial Affairs of the American College of Cardiology suggested a new twist: those who wish to become donors might sign a contract that would provide a payment to their families at the time of donation—death. (Incentives would not be allowed for living donors.) The report said that such contracts "could overcome the psychic costs" of donation as well as "enhance donor autonomy." That is, families would no longer be burdened with the decision to donate, nor could they overrule anyone's wish to donate.

But partnership spokesperson Drachman cites Gallup results in which 78 percent of respondents said financial incentives would not influence them, 12 percent said they would be more likely to donate, and 5 percent said they would be less likely. "It's almost a wash from the public perspective, and it would alter the whole sense of altruism on which donations are now based." Furthermore, she says, "We did a survey of people in hospitals who are involved in the donation request. They indicated that they would be much less comfortable presenting the option of donation to families if they needed to tell them that there would be a financial incentive."

Compensation also creates an incentive for dishonesty that could ultimately contaminate the organ supply, adds Richard Luskin, director of the New England Organ Bank, the largest OPO in the country. "We're dependent on the family to tell the truth about the clinical history of the donor. Once you put money in the middle of that, you're encouraging people to be less than honest."



Problems in "Death Management"

Meanwhile, clinicians are trying to increase the organ supply by focusing on techniques for organ preservation. When kidney transplantation first began, patients whose hearts had stopped beating were a routine source of organs. But problems with "warm ischemia"—the rapid destruction of tissue following the cessation of heart function—led to widespread abandonment of this protocol in the 1970s. Brain death, or death as determined by established neurologic criteria, became the standard measure for identifying a potential organ donor. In brain death, the warm ischemia problem is sidestepped because the patient's organs can be maintained for one or more hours as the heart continues to pump. Now, however, practices have been developed to minimize the warm ischemia problem, so that the pool of potential donors may be expanding beyond brain-dead patients to include patients whose hearts stop beating before brain death ever occurs.

One such protocol is already in use at the University of Pittsburgh Medical Center. With the permission of donors and their families, the hospital recently began weaning patients from respirators with surgeons standing by to remove the organs two minutes after the heart stopped. The nature of death under such conditions has sparked controversy, though. In a recent article in the *Kennedy Institute of Ethics Journal*, Renee Fox, a sociologist at the University of Pennsylvania, deplores "the desolate, profanely high tech death that the

patient/donor dies, beneath operating room lights, amidst masked, gowned, gloved strangers, who have prepared his (her) body for the eviscerating surgery that will follow. This contrasts sharply with the procedures that the nursing and medical staff responsible for the care of hospitalized, nondonor patients try to follow when they sense that an imminent death is approaching."

Another controversial procedure has been developed by the Regional Organ Bank of Illinois (ROBI) to preserve kidneys that might otherwise rapidly deteriorate while a family is approached about organ donation. Doctors at some hospitals will soon infuse a cold preservation solution into the abdomen of patients who have died in the emergency room or are dead on arrival. "It's a minimally invasive procedure," says ROBI president Jarold Anderson. "It gives the family time to be contacted and asked whether they would like to donate their loved one's organs."

But Robert M. Arnold, an ethicist and internist at the University of Pittsburgh Medical Center, notes that "the catheters and infusants are put in before anyone asks the family." And he adds that the question of when to stop resuscitating the patient and begin preserving the organs remains unresolved.

The Pittsburgh and ROBI protocols could provide between 20 and 25 percent more organs, according to a study by the Delaware Valley Transplant Program. Nevertheless, Arnold firmly believes that before new approaches are widely adopted, the impact on public perception and willingness to donate needs to be studied more carefully.

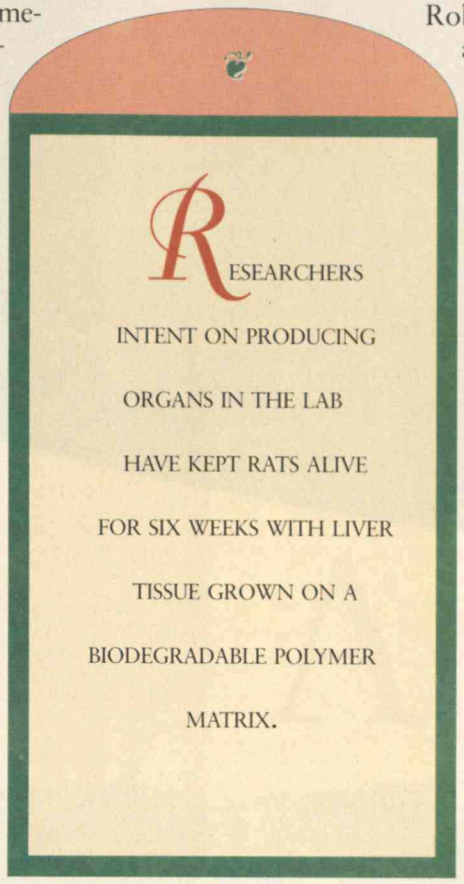
Beyond Human Donors

An alternative way to expand the donor pool might be to use cross-species transplants, known as xenografts, and here again the University of Pittsburgh Medical Center finds itself in the eye of the transplantation storm. In June of 1992, surgeons there performed the first liver transplant from a baboon. The team went on to transplant a second baboon liver six months later. Neither patient survived, making the surgery the twenty-eighth unsuccessful cross-species transplant in history. The Pittsburgh doctors had argued that a better understanding of the immune system, combined with the use of an experimental immunosuppressive drug, FK-506, justified the surgery.

Not everyone agreed. "At the time of surgery, there was some question about whether there was adequate testing of this concept," says Anthony Monaco, chief of the division of organ transplantation at the New England Deaconess Hospital. He notes that the Pittsburgh team had based its decision to proceed in part on hamster-to-rat liver transplant experiments. "Of course, now they've done a large animal experiment, and the large animal is man."

Even if baboon xenografts could somehow be made to work, a major difficulty with them is the risk of introducing primate diseases, Monaco says. "The problem is that if you go from a species like baboon to humans, viruses that inhabit baboons could inhabit humans. This has always been a concern with that kind of xenograft as opposed to a pig or a cow to humans, where the viruses are less likely to be transferable."

Others point out that baboons and chimpanzees are not a suitable source anyway. "Chimpanzees are more endangered than people," says the Coalition on Donation's Wolfe, "and breeding baboons in captivity for their organs would be prohibitively expensive." He does not completely discount the potential of xenografts, but thinks they should not be done from our closest species relatives. And he adds that in order for them to work, scientists must either develop drugs to stop organ rejection in such transplants or use biotechnology to engineer organs that do not trigger the immune response that leads to rejection.



The latter is one of the goals of the Princeton-based DNX Corp., which is injecting clones of human DNA into the fertilized eggs of pigs. The hope is that the organs of these bioengineered pigs could be harvested and transplanted into humans. Even if the researchers succeed, however, the cost of such organs may prove prohibitive. "Some people now project that it would cost a quarter of a million dollars per animal," says Mudge of Brigham and Women's. "I'm not sure that as a society that we have those financial resources." DNX's John Logan, vice-president of research and preclinical development, disputes such enormous estimates, noting that the aim of the company is "a product that does not increase the overall cost of transplantation."

Other researchers have turned their energies to growing organs without the help of genetic engineering. Scientists at MIT and Children's Hospital in Boston are learning how to grow cartilage, liver, skin, muscle, intestinal and urinary lining, and bone tissue. "If we can't find replacement organs, we'll build them," says Joseph Vacanti, associate professor of surgery and director of Children's organ transplant service. He and Robert Langer, a professor of chemical and biomedical engineering at MIT, have grown cartilage in the shape of a human ear inside a mouse, and have kept rats alive for more than six weeks with laboratory-generated liver tissue.

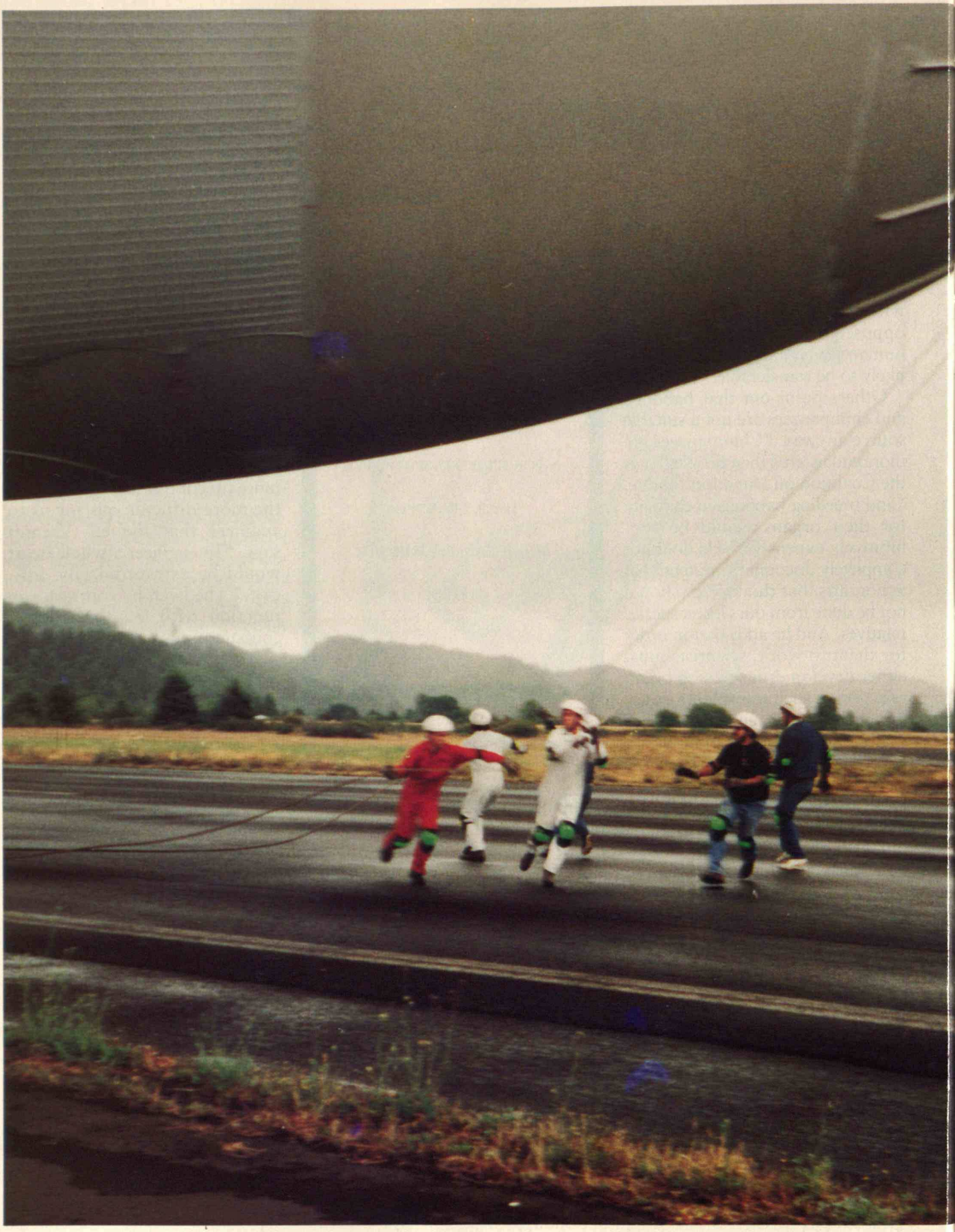
Vacanti and Langer have developed a system in which a biodegradable polymer matrix serves as a scaffolding from which the living tissue can take structural cues. The scaffolding first encourages the tissues to grow and then slowly dissolves after the transplant has been completed. There is one catch, though. "The more function is tied to structure, the more difficult it is for us to engineer that tissue," Vacanti says. "To engineer a whole heart would be extraordinarily difficult." The liver, by contrast, can function with less-than-perfect configuration.

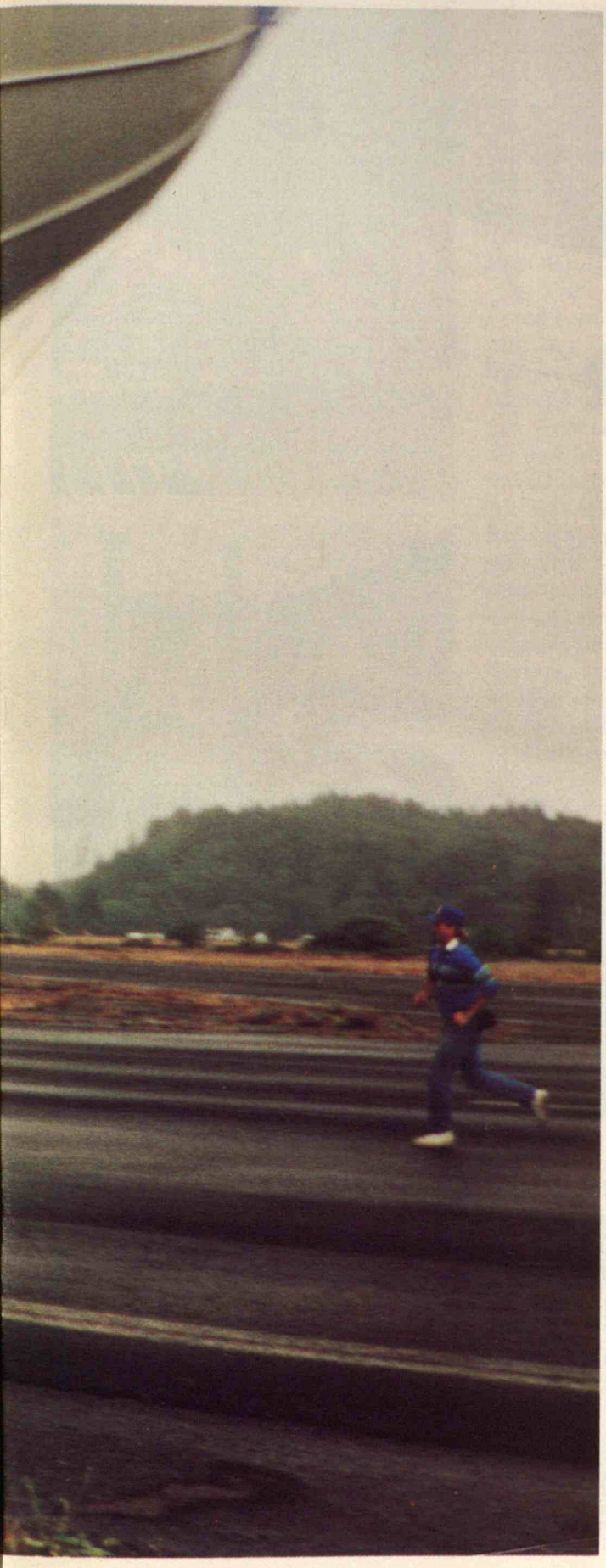
A Human Responsibility

The best hope for increasing the number of donor organs is likely to be a cocktail rather than a magic bullet—a combination of education campaigns and, further down the road, technological breakthroughs. While Vacanti believes "the design of new technology of one form or another is central to solving the problem of organ scarcity," he also thinks lay and professional education is "important and should continue."

Others stress that education hasn't been given enough of a chance. "Donation and transplantation are on a lot of people's minds," says the partnership's Drachman. "If we can catalyze the American public, and work in a focused manner with professionals to help the American public act on its positive intentions, I think that within five years we could see a significant difference."

"There are no quick fixes," says Wolfe, who nevertheless believes public education spearheaded by the Ad Council's upcoming national campaign is the key. "Look at the time it has taken to change public attitudes about smoking. We have to keep the pressure on people." He emphasizes that "it's a human responsibility to give your organs and tissues away when you don't need them anymore. And if you let people off the hook, no other scheme is ever going to work." ■





Blimps on the Rise

BY MICHAEL BARNES

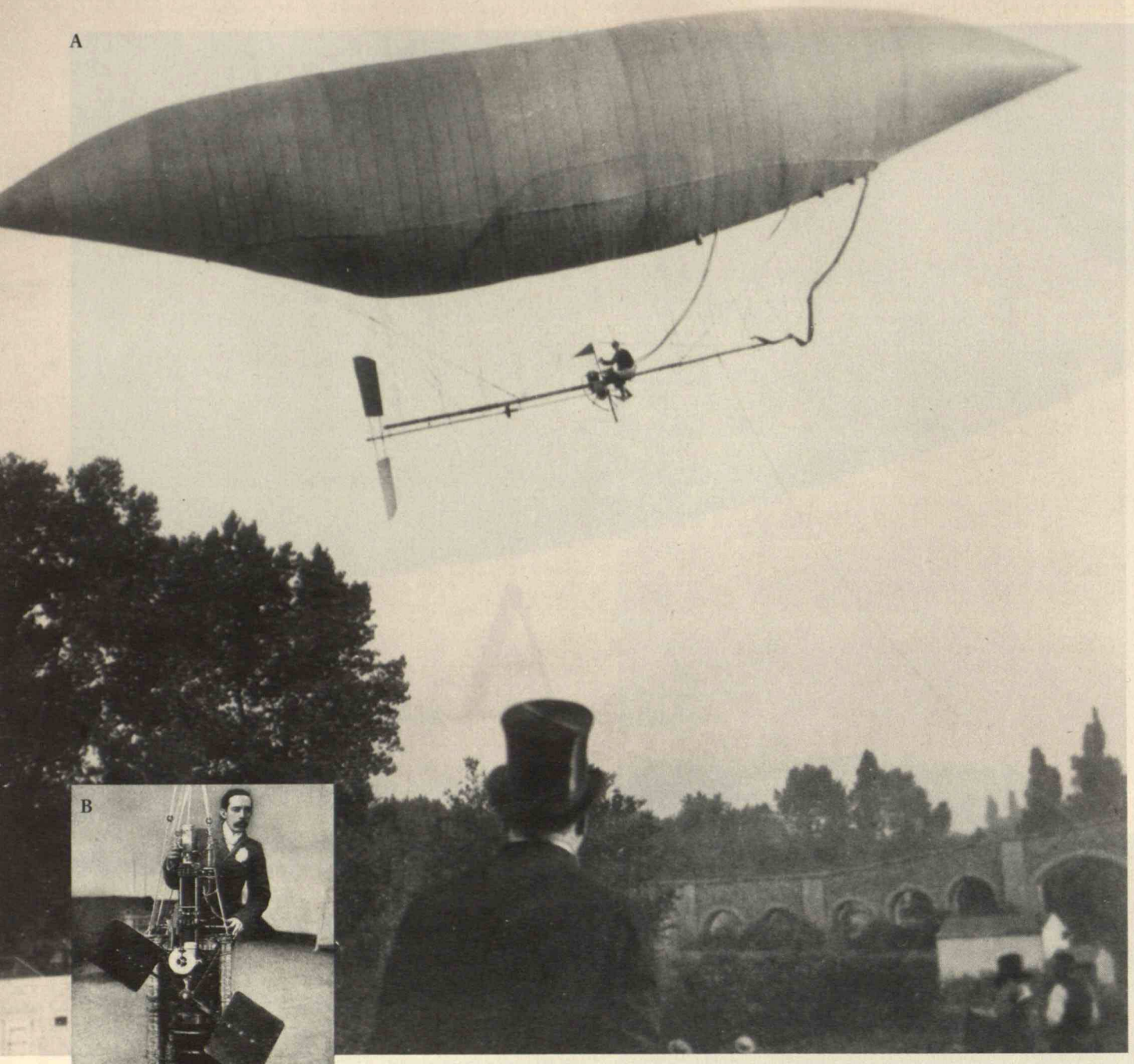
AFTER a blimp advertising Pizza Hut collapsed over New York City last summer, the

local press seemed to rediscover the rotund airship. The coverage was generally light-

hearted. The *New York Times* headlined a story "A Busted Blimp Releases a Large Giggle Factor," while a *New Yorker* cover showed an "E-Z Blimp Park."

Yet blimps are not just

A



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C

good for laughs, according to the designers behind a variety of new lighter-than-air craft created in recent years. Uses for them include scientific monitoring and military and border-control surveillance—as well as, of course, advertising. "The reality is that there is only a tiny niche in the aviation market for blimps, but I am convinced that there is a viable future for the new generation of these airships," says James Thiele, an Oregon blimp designer and aficionado since childhood.

The first practical blimp made its appearance on Sept. 20, 1898, when Alberto Santos Dumont—a young Brazilian living in Paris—rose up from the ground in a dirigible, or steerable, balloon. Santos Dumont had attached a propeller to his motorcycle's engine and suspended the contraption from a silk, sausage-shaped balloon containing a smaller bag—a "ballonet." He filled the latter with air and the balloon with hydrogen until his craft became lighter

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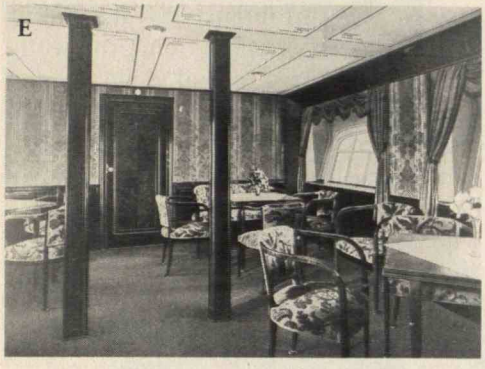
MICHAEL BARNES, *a producer for the public-television science series NOVA, made* The Blimp Is Back!, *a commercially available film that first aired in 1990.*

E



than the surrounding air and began to ascend. As the blimp rose, the outside air pressure dropped, allowing the hydrogen gas to expand and the internal gas pressure to increase. To compensate, Santos Dumont periodically released air through a valve from the ballonet to the outside. On his way down, he reversed the procedure, pumping air into the ballonet to keep the blimp firm.

In 1900, ex-German cavalry officer Count Ferdinand von Zeppelin took the next step in airship design. He filled a lightweight aluminum frame with 17 bags of hydrogen and covered the skeleton with canvas. His rigid airship, devised for carrying passengers, controlled its buoyancy by carrying water that was released to let the dirigible rise. Releasing hydrogen made the vehicle sink. (The fiery crash of the Hindenberg zeppelin in 1937 put an end to the use of hydrogen as a lifting gas and to the Count's internal-frame design. From then on, others saw rigid airships as too bulky, costly to build, and difficult to fly. Moreover, by the end of World War II, airplanes were clearly superior for carrying passengers long distances.)

Much of the current revival of activity

***A-C:** Albertos Santos Dumont, who developed the first practical blimp, built several airships, including one that circled the Eiffel Tower in 1901 as part of a 100,000-franc contest.*
***D:** The frame of the 785-foot* U.S.S. Macon, *built in 1933, was so large that the rigid airship could stow five fighter planes.*
***E:** Over the course of 590 flights, largely transatlantic, 40,000 passengers became familiar with the spacious interior of the* Graf Zeppelin.
***F:** The* Hindenburg, *a rigid airship relying on hydrogen gas, exploded in 1937.*

(SOURCE: *DIRIGIBLES THAT MADE HISTORY,* BY DAVID C. COOKE)

F

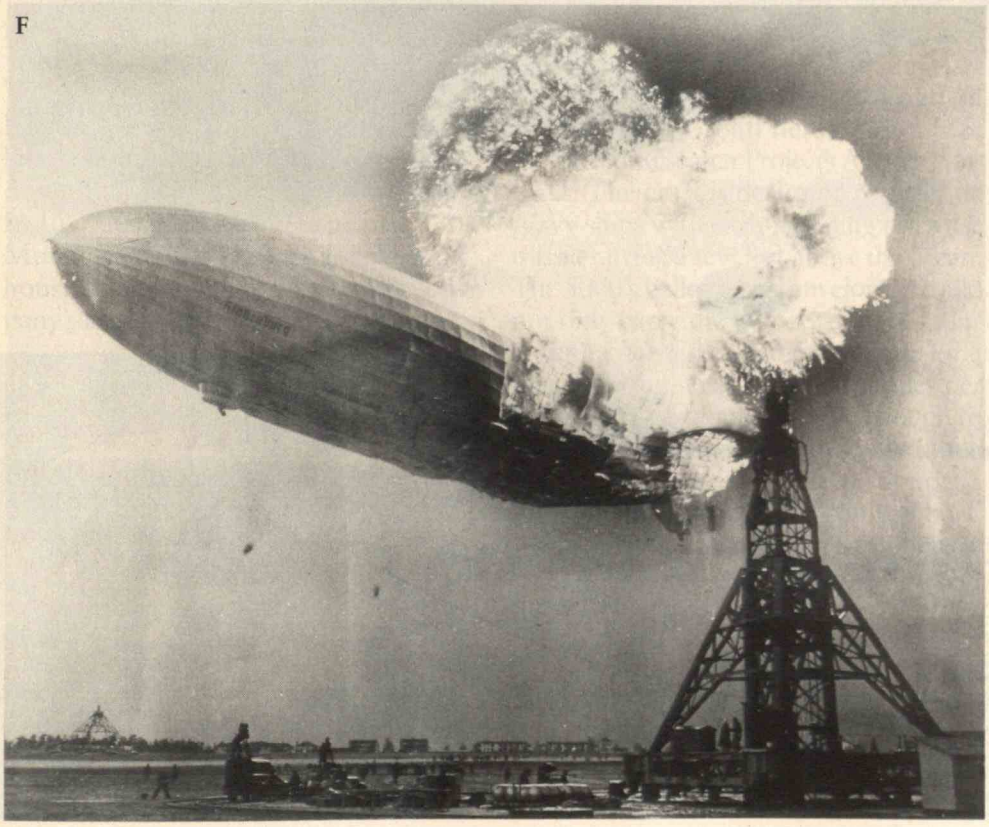
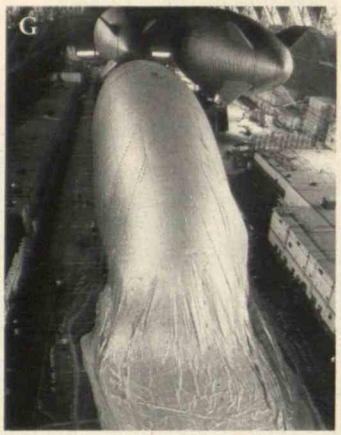


PHOTO CREDITS:
PREVIOUS SPREAD, TOP TO BOTTOM: RONALD HOCHSTETLER, JAMES THIELE, DANIEL DROLLETTE, RONALD HOCHSTETLER **A, B, C, E, F:** COURTESY OF SMITHSONIAN INSTITUTION **D:** U.S. NAVY **G, H:** LORAL DEFENSE SYSTEMS **I:** RONALD HOCHSTETLER **J:** COURTESY OF AIRSHIP MANAGEMENT SERVICES **L:** COURTESY OF TCOM **M, N:** RONALD HOCHSTETLER **O:** JAMES THIELE

***G:** A Goodyear blimp is blown up under an "inflation net," without which it would rise up to the top of the hangar.*
***H:** Navy blimps built by Goodyear protected ships off the Atlantic coast during World War II.*



in dirigibles, all descendants of Santos Dumont's series of blimps, has come about because of Roger Munk, the founder and chief designer of the British company Airship Industries. In 1979, after an approximately two-decade hiatus in blimp design (three of the Goodyear blimps used for advertising and TV shots of sporting events are similar to those built during World War II to protect merchant ships off the U.S. coast from Hitler's U-boats), Munk flew his first airship. It led to several major innovations in blimp design.

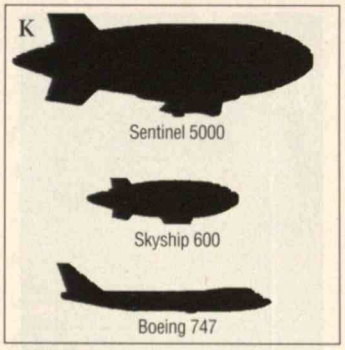
The most important involved housing engine propellers in ducts that could swivel in such a way that air exiting from them would push against the ground and assist in liftoff and ease in landing. Munk also took advantage of new lightweight, long-lasting polyurethane fabrics for the gas "bag" and radar-absorbent materials such as Kevlar for the gondola. The latter innovation, along with the elimination of metal from all parts but the engine made his blimps stealthy, an asset for military applications. And Munk introduced fly-by-light steering, in which a tiny joystick connected by optical fibers to small motors that control rudders and elevators (which point a ship up or down) replaced the heavy cable-and-pulley system.

In the 1980s, Munk's company built and operated 14 airships. Although these were not primarily used for surveillance, as he had hoped, in July, 1989, one of his Skyship 600 blimps hovered over Paris for seven days (except for two-hour daily pitstops) to help protect the numerous heads of state that the French government had invited to attend the celebrations of the French Revolution's 200th anniversary. The Paris police employed video cameras, attached to the underside of the blimp's gondola, that could identify people more than than a mile away and thus monitor the dignitaries' safety unobtrusively. If trouble had developed on the ground, the security forces figured, aerial views would have provided the best images for coordinating police action. The choice of the blimp came about because, according to Police Inspector Raymond Demateis, who headed the incident-free operation, "helicopters are very noisy, and Parisians

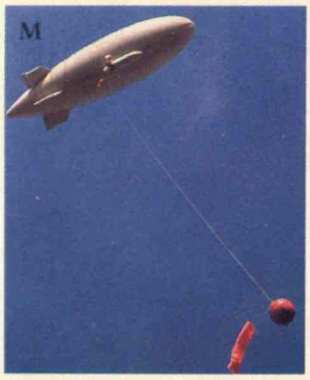
are very sensitive about aircraft noise."

Munk sold a Skyship 600 to the Tokyo police after the Paris operation, but with his blimps selling for $4.5 million or leasing for $300,000 a month, no other sales materialized before Airship Industries went bankrupt in 1990. Munk then went to work for Westinghouse Airships, which bought his company's assets. Since then, Munk has concentrated on designing the Sentinel 5000, the biggest nonrigid airship ever attempted (at 425 feet long, the length of almost 1.5 football fields), for a U.S. Advanced Research Projects Agency contract. The craft is designed to provide Navy ships with early warning of cruise missiles flying a few feet above the ocean. The 5000's balloon, or "envelope," could not only carry the billboard-sized radar antenna needed to detect a 6-foot-long missile flying several hundred miles per hour, but also would be large enough to keep aloft the payload—including fuel, food, and water—needed to support a crew for up to 30 days. The blimp, if built, will hold 2.5 million cubic feet of helium and should be able to float 10,000 feet above sea level.

Meanwhile, in a new effort to combat bombings in Britain, the United Kingdom Ministry of Defense has bought the first of possibly several blimps from Westinghouse. The agency plans to equip its Skyship dirigible with surveil-



***I, J**: A Skyship 600, designed by blimp innovator Roger Munk, waits for its gondola to be connected, while a sister ship flies over the Thames River in London.*
***K:** The Sentinel 5000 would be the largest non-rigid blimp ever developed, larger than a Boeing 747.*



lance equipment such as directional microphones to intercept ground conversations and thermal imaging systems to track people at night. The craft's crew should be able to coordinate security forces from a cruising altitude of 5,000 feet, out of the range of small-arms fire.

For the past 20 years, surveillance has also been provided by tethered blimps, or aerostats. Essentially blimps without engines and gondolas, aerostats are attached to the ground by 20,000-foot-long cables that also carry radar signals received by antennae inside the balloons and power to operate the antennae. Attractive because they can stay in one place for long periods and they need only small ground crews (unlike other blimps), aerostats were used near the end of the Vietnam War. And such a device first detected Iraq's invasion of Kuwait. The U.S. Customs Service is in the midst of stationing 16 tethered blimps, each costing some $22 million (the price-tag covers electronics, a winching system, and necessary "base-camp" installations), along the southern U.S. border as part of the effort to deter illegal-drug flights into the country. One southern-border aerostat installed by one supplier early on deflated and the tethers of two of its others broke. But the government decided to stick with the program—using a system from another supplier—following Senate hearings that suggested that tethered blimps provide economical surveillance compared with radar-carrying airplanes.

Another kind of monitoring has been conducted using a blimp built by US-LTA of Delta, British Columbia. The Naval Research Laboratory wanted a platform from which to measure wind speeds just above the ocean's surface. The models that are used to predict worldwide weather systems such as El Niño and are the basis for decisions about global warming have relied on inaccurate measurements of these speeds, because the presence of the ships and helicopters that have recorded them

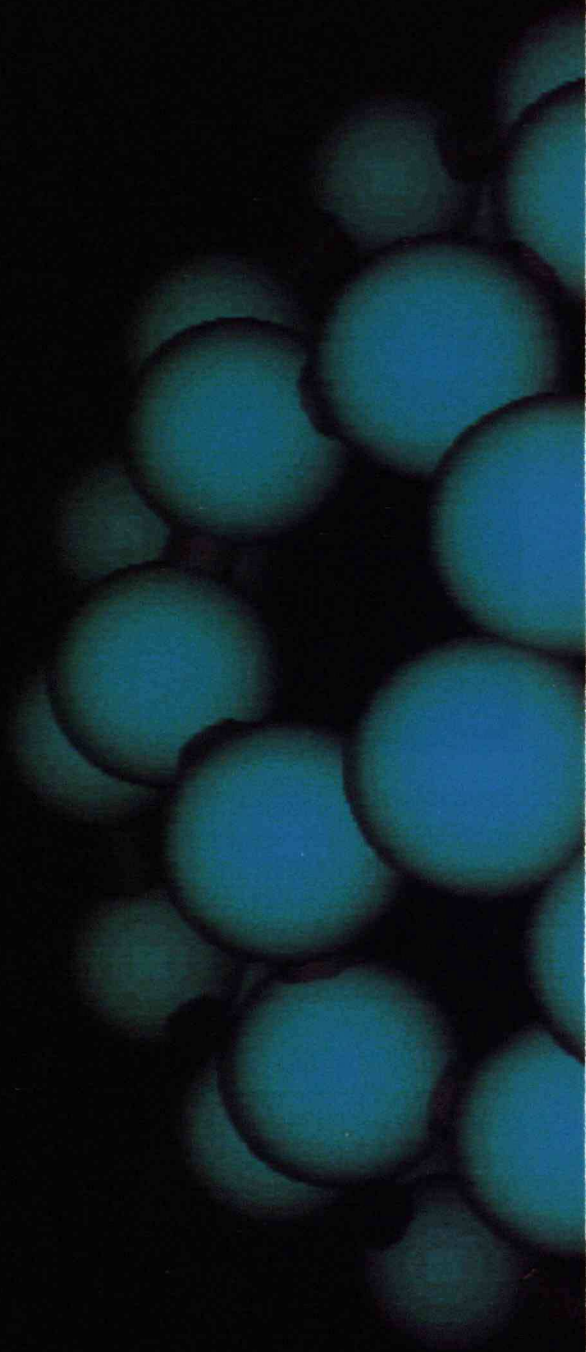
disturbs air movements. But blimps can float high over the sea without affecting the recording of instruments dangling below, says Ronald Hochstetler, a consultant with Veda, an Alexandria, Va., firm that evaluates blimps' scientific and military potential for the government.

A more traditional use of the blimp—advertising—has also been exploited in a new way since the late 1980s. Thiele's Oregon-based American Blimp Corp. has developed the relatively inexpensive ($1.4 million) Lightship. It incorporates a powerful light source suspended from inside the balloon, protected in a cage. At night this illuminates the translucent bag so that it glows like a UFO. The balloon is novel for a blimp—polyester coated with a plastic film that is transparent to visible light yet contains pigments that block ultraviolet rays that would usually damage fabric quickly. Since helium would leak through this "envelope," Thiele's design calls for the lifting gas to be contained in an inner polyurethane bag. (The balloon on other blimps is made of polyester coated with light-blocking rubber or urethane that prevents helium leakage and protects against ultraviolet wavelengths.) Richard Branson, the British founder of Virgin Atlantic Airways, has bought four Lightships for an advertising venture, while a Japanese company is leasing one to promote sales of a vitamin drink.

But could business activity in blimps falter because of the one that collapsed and draped itself over a New York apartment building? The two crew members escaped serious injury, which may have helped the interest in lighter-than-air craft, says George Spyrou, president of blimp-operating company Airship Management Services of Greenwich, Conn. Even when a blimp has a substantial hole in its balloon, he says, it doesn't "drop out of the sky like a stone. The helium gas is under such low pressure that it usually escapes slowly enough to allow the crew to land in one piece."

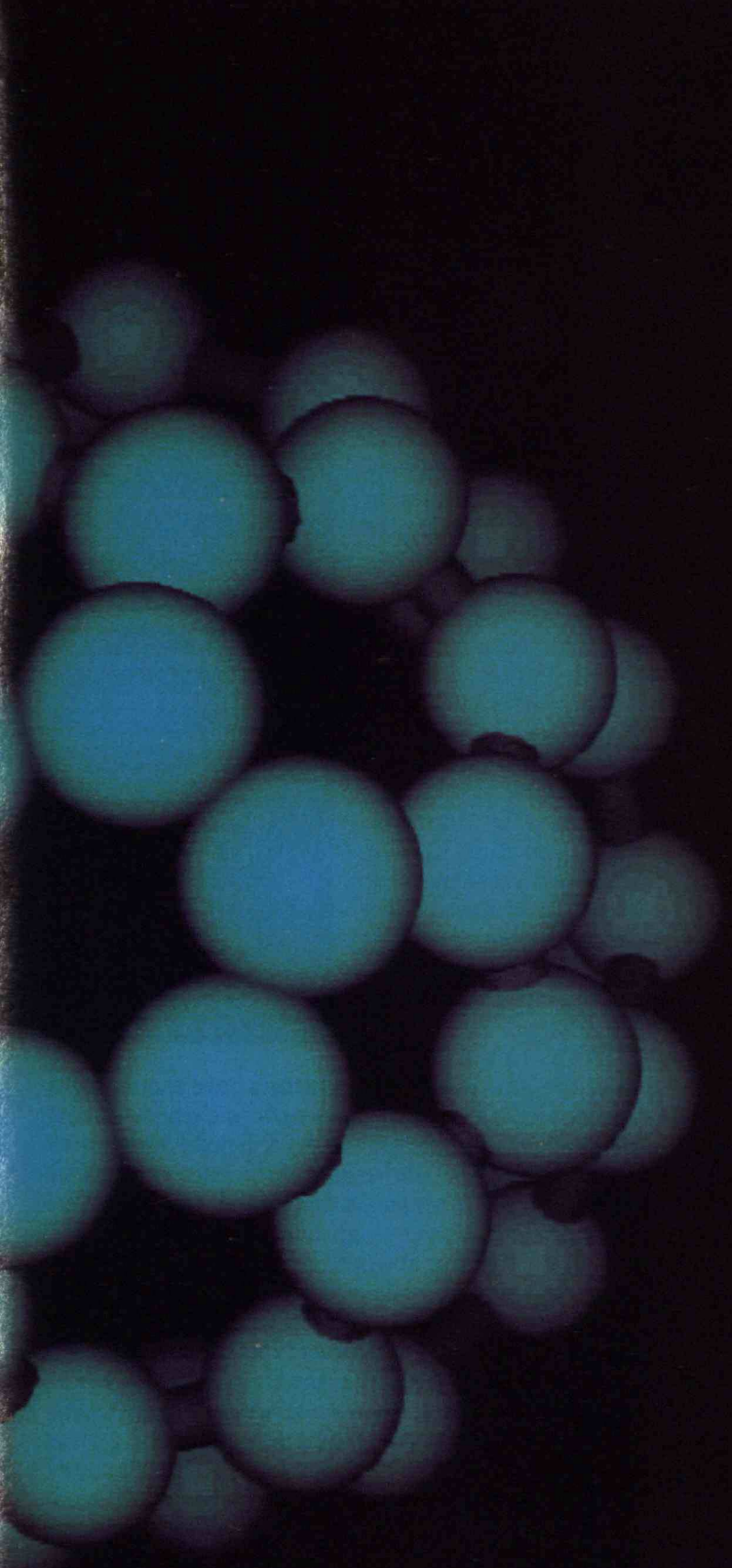
***L:** Numerous lines on an "aerostat" blimp connect to the ground-based tether on its belly.*
***M:** Recognizing that the steadiness of blimps makes them useful for some scientific work, the British Radar Systems Research Establishment used a blimp to help it calibrate on-ground radar. The attached ball had a known radar "footprint."*
***N:** Pilots peer out from a US-LTA blimp used to measure wind speeds near the sea's surface.*
***O:** Workers position an advertising banner on a Lightship.*

The Third Coming of Carbon



Although hopes for "buckyballs" border on messianic, practical uses for the talented molecules have yet to emerge. They may find their true calling in 21st century micro-electronics and nanotechnology.

By Hugh Aldersey-Williams



It isn't easy being Molecule of the Year. For buckminsterfullerenes, the new class of carbon discovered in 1985 and nominated to stardom by *Science* Magazine in 1991, fame and fortune have been a mixed blessing. Along with an explosion of interest—scientific papers on fullerenes have been appearing at the rate of more than one a day—have come high hopes that are not always realistic. Research on fullerenes is still in its formative stages. Only when their physics and chemistry are better understood will these versatile molecules find their way into useful products and processes.

To be sure, the hoopla is understandable. For millennia, the only known forms of pure carbon were diamond and graphite. Thus the discovery of a third form is remarkable in itself. So much the better that fullerene molecules are relatively easy to come by: not only can they be created by zapping carbon with a laser or an electric arc, but they may even be fairly abundant in nature, as attested by the recent unearthing of fullerenes in carbon-rich geological formations.

Still more intriguing are the structure and properties of this new molecular species. The first fullerene to be isolated, C_{60}, consists of 60 carbon atoms arranged in the most highly symmetric form of any molecule known: a hollow sphere made up of hexagons and pentagons—in short, a soccer ball. It is because of their shape that the molecules were named for the maverick architect Richard Buckminster Fuller, who popularized geodesic domes, and that they received the nickname "buckyballs." The discovery of C_{60} was quickly followed by the discovery of new fullerenes both with more and with fewer carbon atoms.

The buckyball quickly proved to be a molecule of many talents. Fullerenes act like metals in some circumstances, like semiconductors in others. Suitably treated fullerenes show still more exotic behavior, including superconductivity—the ability to conduct electricity with no loss of energy. Then there is the molecules' unusual hollow-cage shape, large enough to trap an atom of virtually any element of the periodic table. The cage could chemically isolate such an atom while it was being transported from one environment to another.

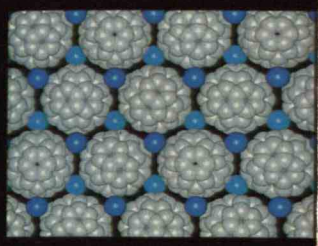
The exterior shell of the fullerenes, with its array of carbon-carbon bonds, is interesting, too. It is possible to break the bonds between pairs of carbon atoms and add atoms of another element at different sites on the molecule. This procedure can lend the fullerene new chemical properties while preserving its toughness and stability.

The unusual size and shape of the fullerenes also suggests they could be "biologically active." Any new shape is of interest in the lock-and-key world of protein and enzyme biochemistry, especially when that shape is based on carbon, the element at the root of life.

The novel properties of C_{60} and its kin immediately gave rise to speculation as to what this new class of carbon molecules might be good for. As it turned out, some of the early hopes for fullerenes were to be cruelly dashed. Others have hit stumbling blocks or have proved to be frustratingly remote. Indeed, there can be no more salutary lesson regarding the folly of expecting a quick payoff for discoveries in fundamental science than that provided by buckminsterfullerene.

HUGH ALDERSEY-WILLIAMS, based in London, is author of a forthcoming book on buckminsterfullerene, The Most Beautiful Molecule.

In their paper announcing the discovery of C_{60} in 1985 (*see "A Star Is Born," page 60*), Richard Smalley, a professor of physics and chemistry at Rice University in Houston, and Harold Kroto, a chemist from the University of Sussex in England, floated the idea of Teflon ball-bearings. They imagined that one might add a fluorine atom to each carbon in buckminsterfullerene to obtain a "superlubricant"—a spherical version of the carbon-fluorine polymer Teflon. But when a team from Kroto's laboratory at Sussex and two other British universities finally succeeded in fluorinating C_{60} to form $C_{60}F_{60}$, the result was dismaying. Moisture in the air produced highly corrosive hydrofluoric acid, rendering any lubricant property useless.



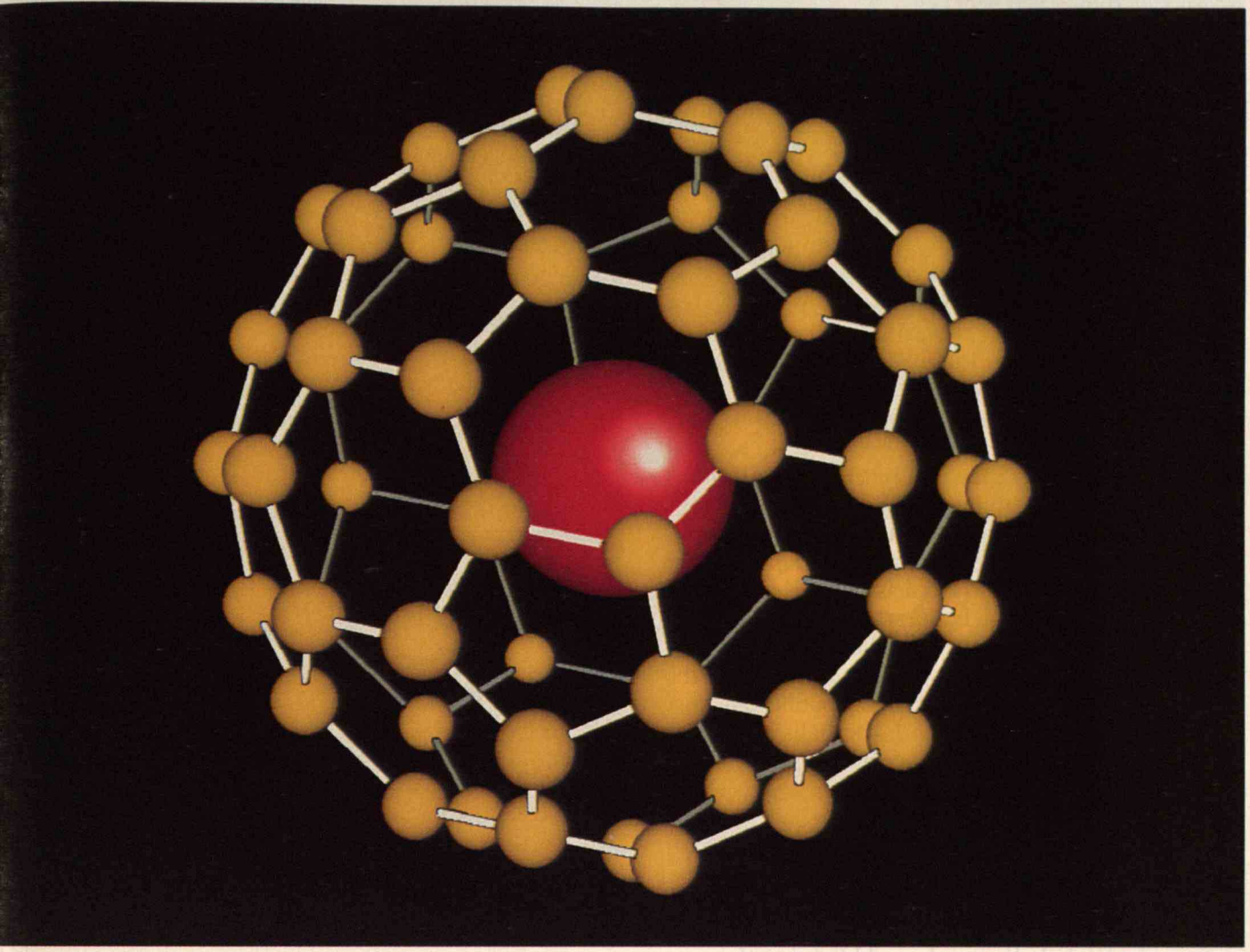
Buckyballs possess a range of exotic properties. Their hollow structure (right), for example, allows them to cage atoms of other elements, altering their chemical behavior. Buckyballs can also conduct electricity with no energy losses when combined with certain metal atoms. But so far fullerene-based superconductors—such as the one AT&T Bell Labs created by adding potassium atoms (shown in blue, above)—degrade readily in air.

Efforts to turn buckyballs into practical superconductors have encountered similar obstacles. Researchers such as chemist Robert Haddon and his colleagues at AT&T Bell Laboratories have "doped," or adulterated, fullerenes with alkali metals to produce a material that loses its electrical resistance at the relatively high temperature of -240°C, which is 33° above absolute zero. Unfortunately, the doped fullerenes degrade readily in air. The search continues for more stable fullerene/dopant combinations.

A team from Emory University in Atlanta and Fred Wudl, an organic chemist at the University of California at Santa Barbara, created a sensation this past summer when they reported that a derivative of C_{60} was active against HIV, the virus that causes AIDS. But they perhaps made a tactical error in trying to link the sexiest new molecule on the block with the most notorious virus. Many substances are in fact "active" against HIV, and Raymond Schinazi, a viral pharmacologist at Emory University School of Medicine, says the recent finding simply demonstrates the first biological activity of any fullerene chemical; it doesn't prove that buckyballs hold great clinical promise in the fight against AIDS.

Likewise, much has been made of the potential for

PHOTOS PRECEDING PAGE: SCOTT CAMAZINE/PHOTO RESEARCHERS, INC.; RICHARD SMALLEY, RICE UNIVERSITY



using the carbon cage of a fullerene within the human body to transport radioactive elements such as radon to treat cancer. In theory, the cage would prevent the element from reacting chemically with the body while still permitting therapeutic radiation to escape. Yet this is perhaps among the more distant fullerene applications. The biological properties, and hence the safety, of fullerenes are still largely unknown, and it is unclear how the caged element would be transported within the body.

Equally far off is the notion examined at NASA's Jet Propulsion Laboratory of using fullerenes in ion-drive engines. Such engines would propel a spacecraft by ejecting heavy charged particles that had been accelerated in an electric field. Fullerenes have the advantage of being both easy to ionize and much more massive than the heaviest alternatives, which are single atoms. But with most groups still making fullerenes only in gram quantities, it will be a while before anyone is able to fill a rocket fuel tank with them.

Eight years after its discovery, buckminsterfullerene remains a star in search of a vehicle. "As far as I know, there is no application of buckyballs on which money is being made," says Smalley. But as he and others point out, it took years for many important discoveries—from electromagnetic induction to liquid crystals—to realize their commercial potential. For fullerenes, the first commercial payoff could come from any number of more prosaic applications now being studied. And ultimately, the molecules could find their niche as the building blocks of tomorrow's nanotechnology devices.

Less Glamour, Better Prospects

Fullerenes have many other properties that can be exploited besides those that have made headlines. One is their resilient ball shape. "They are impervious to fragmentation and high-speed collisions. They bounce off surfaces," says physicist Lowell Lamb at the University of Arizona in Tucson. It was Lamb who, along with his colleague Donald Huffman and a team at the Max Planck Institute for Nuclear Physics in Germany, first developed a technique for making buckyballs in usable quantities. The balls' super-resilience could lead to some novel uses, though no one is sure what.

For scientists whose experiments require carbon of extremely high purity, moreover, the buckyball may be just the thing. "It is about the purest form of carbon in

PHOTOS ABOVE: BIOSYM TECHNOLOGIES, INC.; SCOTT CAMAZINE/PHOTO RESEARCHERS, INC.

terms of casual handling," says Lamb. Whereas both diamond and graphite attract a layer of hydrogen on their surface, fullerene molecules have no unsatisfied bonds to draw contaminants.

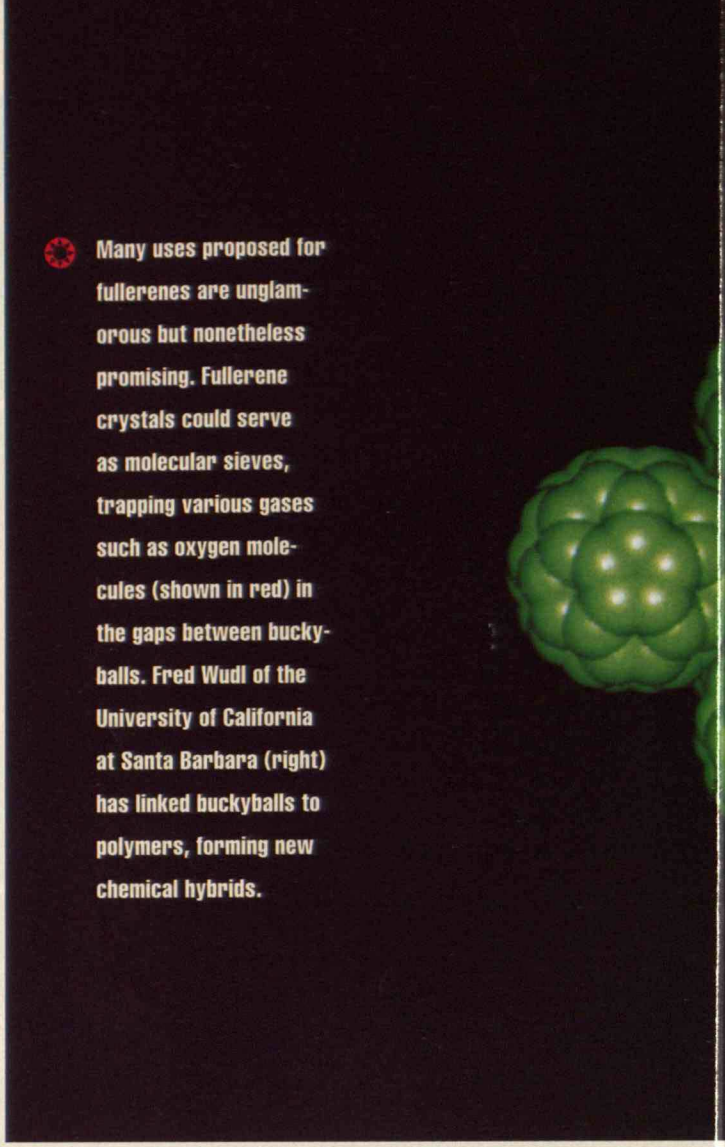
C_{60} solutions also exhibit a variety of nonlinear optical characteristics: shine light into them, and the light you get out is not what you expected. In some cases the frequency is altered. In others, the brighter the incoming light, the less light the fullerenes transmit. Other materials have this light-cutting property, but in fullerenes it operates at lower light levels. Fullerenes may therefore have the potential to protect eyes or sensitive photodetectors from the light of lasers or welding equipment.

This same property may give fullerenes a role in the fledgling field of optical computing, where photons take the place of electrons. The molecules could, for example, serve as switches, passing light up to a certain intensity but blocking brighter light. Physicists Alan Kost and Lee Tutt at Hughes Research Laboratories in Los Angeles, who first noticed this behavior in fullerene solutions, are now trying to duplicate it in solid films that, unlike the solutions, would be stable enough for routine handling.

Crystals composed of many buckyballs have their own unusual characteristics. While most crystals consist of arrays of single atoms, fullerenes form crystals in which whole 60-atom buckyballs are stacked like oranges in a produce store. This arrangement leaves appreciable gaps between balls, suggesting that fullerenes could be used to separate different kinds of molecules. Small molecules coming into contact with the surface of a buckyball crystal would lodge in the gaps while larger molecules would pass along unaffected. The small molecules may later be released by heating.

Arthur Hebard, a physicist at Bell Labs, has constructed a membrane a quarter of an inch square and just 100 buckminsterfullerene molecules thick by depositing them on silicon nitride and silicon, then etching these materials away to leave just the carbon. Such a membrane might pass some gases and not others—and thus could be used to, say, purify natural gas supplies by filtering out nitrogen. It remains to be seen, however, whether buckyballs have any real advantages over zeolites, a class of silicate materials used as molecular sieves today.

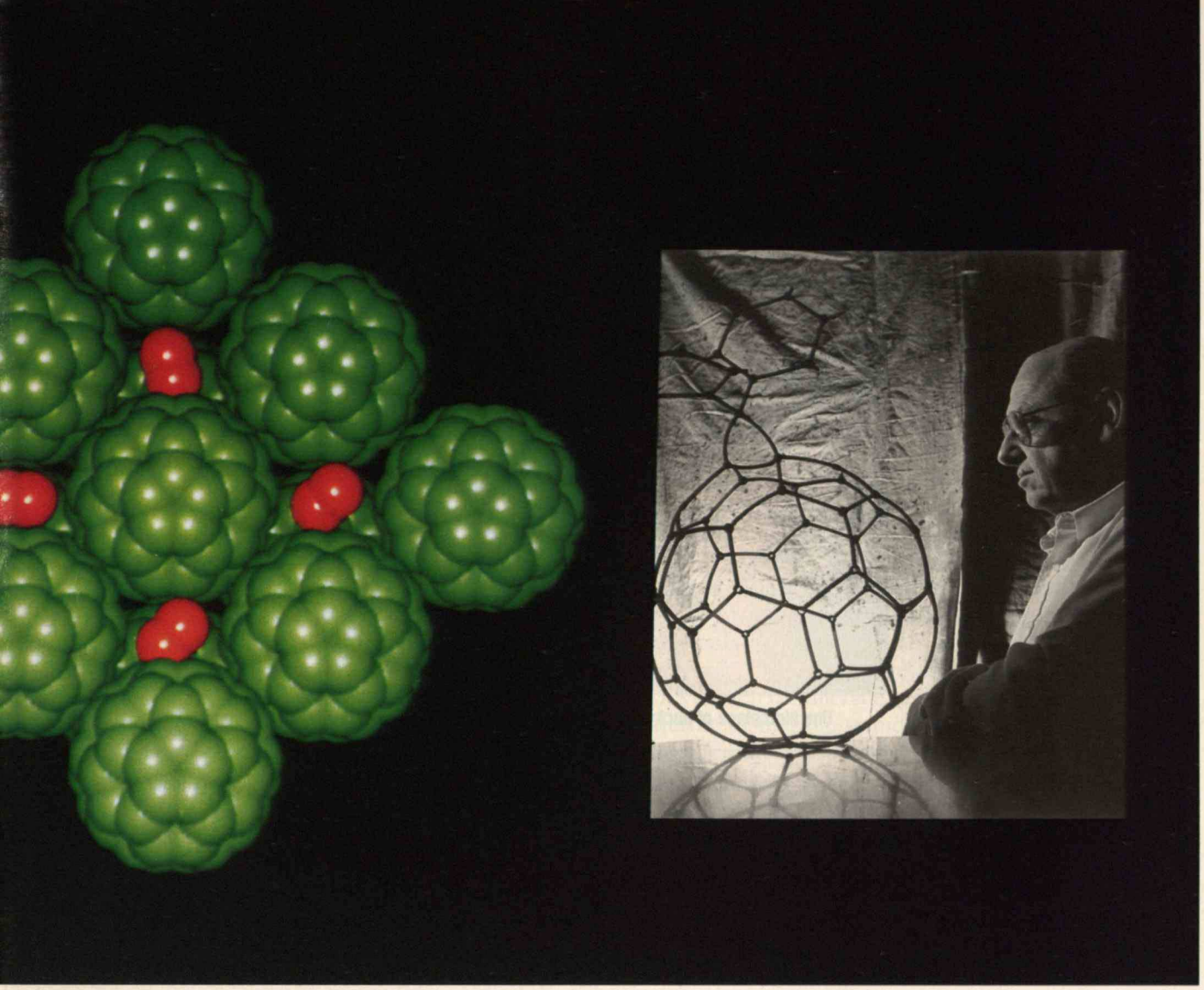
Further off, there is the prospect of controlling the size of the mesh in the membranes, perhaps by linking fullerenes together with carbon chains of different lengths in more or less open networks. These would have some of the porosity of biological materials such as cellulose or bone and might let sugars and amino acids pass but stop larger objects such as viruses and antibodies. Such membranes might be used to protect transplant organs, speculates Lila Anderson of Texas Fullerenes Corp., a Houston-based supplier of buckyballs for research. Because carbon is a "biofriendly" element, she says, a fullerene membrane "wrapper" might help prevent a patient's body from rejecting a transplant.



Many uses proposed for fullerenes are unglamorous but nonetheless promising. Fullerene crystals could serve as molecular sieves, trapping various gases such as oxygen molecules (shown in red) in the gaps between buckyballs. Fred Wudl of the University of California at Santa Barbara (right) has linked buckyballs to polymers, forming new chemical hybrids.

Combining fullerenes with the techniques and materials of conventional organic chemistry gives rise to still other intriguing possibilities. For example, $C_{60}F_{60}$, the fluorinated buckminsterfullerene that flopped as a Teflon-like lubricant, has proved unexpectedly useful as a reaction intermediate. At the University of Sussex, organic chemist Roger Taylor and his colleagues have found that a wide range of chemical groups can displace the fluorine atoms. Some, such as the vinyl and ester groups, are chemically reactive, providing a starting point for building more ambitious fullerene-based chemicals.

Wudl's group at the University of California at Santa Barbara, meanwhile, has linked C_{60} to polymer chains using an extra atom bonded to the fullerene surface as an attachment point. The result is a molecule shaped like a ball and chain. This bonding of long, thin polymers and round fullerenes—each with their own chemical and electrical properties—could create a whole new class of chemistry. It might be possible, for example, to design molecules that are electrically charged on the



polymer end but neutral on the fullerene end. How would such a hybrid behave? Nobody knows, although there is ample reason to expect that these schizoid properties could prove useful. A type of molecule that is water soluble on one end and oil soluble on the other is already in routine use. It's called soap.

The Stuff of Nanotechnology?

Tantalizing as many of these potential applications are, none seems destined to become the star vehicle that justifies the excitement fullerenes have generated. The reason is that each exploits only one of the many properties the molecules have to offer. What makes fullerenes special, after all, is not that they can act as semiconductors or superconductors, or withstand high impacts, or block light selectively. The remarkable thing is that so many useful properties are found in a single basic material. So much the better that this material is carbon, whose propensity to form complex structures is unrivaled, and whose behavior we understand better than that of virtually any other element. Quite possibly the true worth of fullerenes will be revealed only when different properties are exploited simultaneously.

A recently discovered tube-shaped fullerene offers a glimpse of this potential. The preferred way to make buckyballs is by passing an electric arc between two graphite rods, creating a carbon vapor that condenses into soot. It is in this soot that the spheroidal molecules are found. In 1991, however, Sumio Iijima, a physicist at the NEC Fundamental Research Laboratories in Japan, decided to examine the graphite rods themselves, rather than the soot they produced. What he found was a dramatic outgrowth of long "buckytubes." Unlike ordinary carbon fibers, which are made by controlled burning of hydrocarbon polymers, each buckytube is a single giant molecule. If such tubes can be made without defects, they will be extremely strong. But even if they can't, they will still have a major strength advantage over other materials. Because the carbon tube is a strongly bonded network rather than a fragile crystal as in a metal or a ceramic, a small defect will not propagate throughout the structure.

But strength is not the only potential benefit. According to NEC's Thomas Ebbesen, a physicist who in 1992 succeeded in making buckytubes in quantity, two concentric buckytubes may form a tiny wire with an insulating outer shell and a conducting inner shell. This is

PHOTOS: SANDIA NATIONAL LABORATORIES

A Star Is Born

One birthplace of buckyballs: a pair of carbon electrodes.

THE 1985 discovery of buckminsterfullerene, the molecular celebrity of the carbon world, is a classic tale of scientific serendipity. The setting was Rice University in Houston, where Richard Smalley, a professor of physics and chemistry, had built a complex apparatus for creating and probing "clusters."

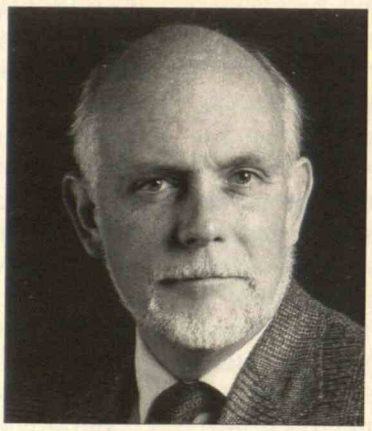
Clusters are aggregates of atoms that usually exist but briefly and under special conditions. They are unlike molecules in that often little is known of the exact arrangement of atoms and bonds within them. And while a stable molecule has the right number of various atoms to satisfy the bonding properties of each, a cluster has bonds left over, dangling hungrily from the atoms on its surface. Although typically unstable, clusters are significant because they represent a mysterious intermediate scale of matter. We know in some detail the characteristics of a given element in the form of a single, isolated atom. An aluminum atom, for example, has 13 electrons, all of which occupy orbitals with known energy levels and three of which may be removed to form aluminum ions. We know also about aluminum in bulk, where there is essentially an infinite number of atoms—its color, density, conductivity, and so forth. But between one and infinity, so to speak, we know next to nothing.

Smalley had been making clusters for several years by blasting a pulse of laser light at a piece of metal or semiconductor. The resulting plume of hot vapor was rapidly cooled in a cold gas that would freeze clusters as they formed and preserve them for examination.

Smalley had recently been studying semiconductors such as silicon, germanium, and gallium arsenide. Here there is a clear need to know about the shadowy region between the atomic and the bulk scale, for the miniaturization of electronic circuitry depends on knowing the behavior of the materials that carry and store data in ever smaller semiconductor devices.

There was, however, no such pressing reason to look at carbon. In fact, it came as something of an interruption when Harold Kroto, a British chemist from the University of Sussex, announced his wish to put carbon into Smalley's machine. Kroto had discovered certain carbon-containing molecules in the cold of interstellar space by analyzing radioastronomy signals. Now he wanted to see if he could make these molecules on earth.

Some of the experiments that Kroto and Smalley undertook, together with Rice graduate students James Heath, Sean O'Brien, and Yuan Liu, did indeed produce the molecules Kroto was looking for. But the researchers soon found themselves drawn into a new mystery.



Rice University's Richard Smalley, codiscoverer of C_{60}.

The team analyzed carbon clusters with a mass spectrometer, an instrument that uses electric and magnetic fields to sort different particles according to their mass and produce a kind of bar chart of their molecular weights. An abundance of a material with a particular molecular weight produces a tall peak on such a bar chart. Normally, clusters show few consistent peaks; their masses vary widely, and because of their many unsatisfied bonds, they are constantly being transformed into other clusters or molecular fragments. In the mass spectra recorded at Rice University, however, there was one peak that just would not go away—a peak representing 60 carbon atoms.

The persistence of the 60-atom peak suggested the presence not of a cluster but of something seemingly impossible: a stable carbon molecule consisting of 60 atoms. Until then, carbon was believed to exist in only two molecular forms: diamond and graphite. If this was indeed a third form of carbon, what was its structure? After much debate, the team agreed that the only way 60 carbon atoms could tie up all their dangling bonds and gain the stability to exist as a molecule was by forming a closed sphere. The researchers tried out different geometries with paper models and concluded that the carbon atoms must be joined together in an arrangement of hexagons and pentagons that resembled the pattern of stitching on a soccer ball. A new class of carbon chemistry was born—at least in theory.

Although their hypothesis was persuasive, Smalley's group and Kroto were powerless to prove it unequivocally. Their equipment could

PHOTOS: GEOFF TOMPKINSON/PHOTO RESEARCHERS,INC.; RICE UNIVERSITY

produce only billions of molecules at a time—orders of magnitude fewer than are needed to verify a molecule's structure by means of spectroscopy or chemical reactions. Five years later, help finally came.

In 1990, Wolfgang Krätschmer and Konstantinos Fostiropoulos at the Max Planck Institute for Nuclear Physics in Heidelberg, Germany, and physicists Donald Huffman and Lowell Lamb at the University of Arizona in Tucson succeeded in making buckminsterfullerene in visible quantities for the first time. The crucible for their efforts was not an elaborate laser apparatus like Smalley's but a simple vacuum chamber with an electric arc between two carbon rods. Where the graphite rods came into contact, an electric current of around 100 amps created a carbon vapor that then condensed on special surfaces or even on the walls of the vacuum chamber. The researchers found that if the vacuum pressure and the spacing of the rods were just right, the soot would contain a small percentage of C_{60}. This could be purified by standard chemical means—vaporizing and recondensing the soot, or dissolving it and extracting the desired constituent. The beauty of the process was that anybody could do it. Within weeks, research groups around the world were making their own fullerenes.

The physicists' discovery was not only a victory for low technology but yet another triumph of serendipity: they had not been looking for C_{60} at all, merely investigating the light-scattering properties of carbon smoke.

A further irony of the fullerene tale is that the research leading up to the discovery was done on a shoestring. No company or foundation specifically funded any search for a new form of carbon or even Kroto's simulated astrochemistry, out of which the buckminsterfullerene discovery came as a happy accident. In fact, Kroto had to raid his wife's bank account for the flight to Houston. A whole new field of carbon chemistry owes its existence to an investment of two weeks' effort on the part of Smalley, Kroto, and their colleagues, combined with generous doses of curiosity, hunch, and blind chance.—*Hugh Aldersey-Williams*

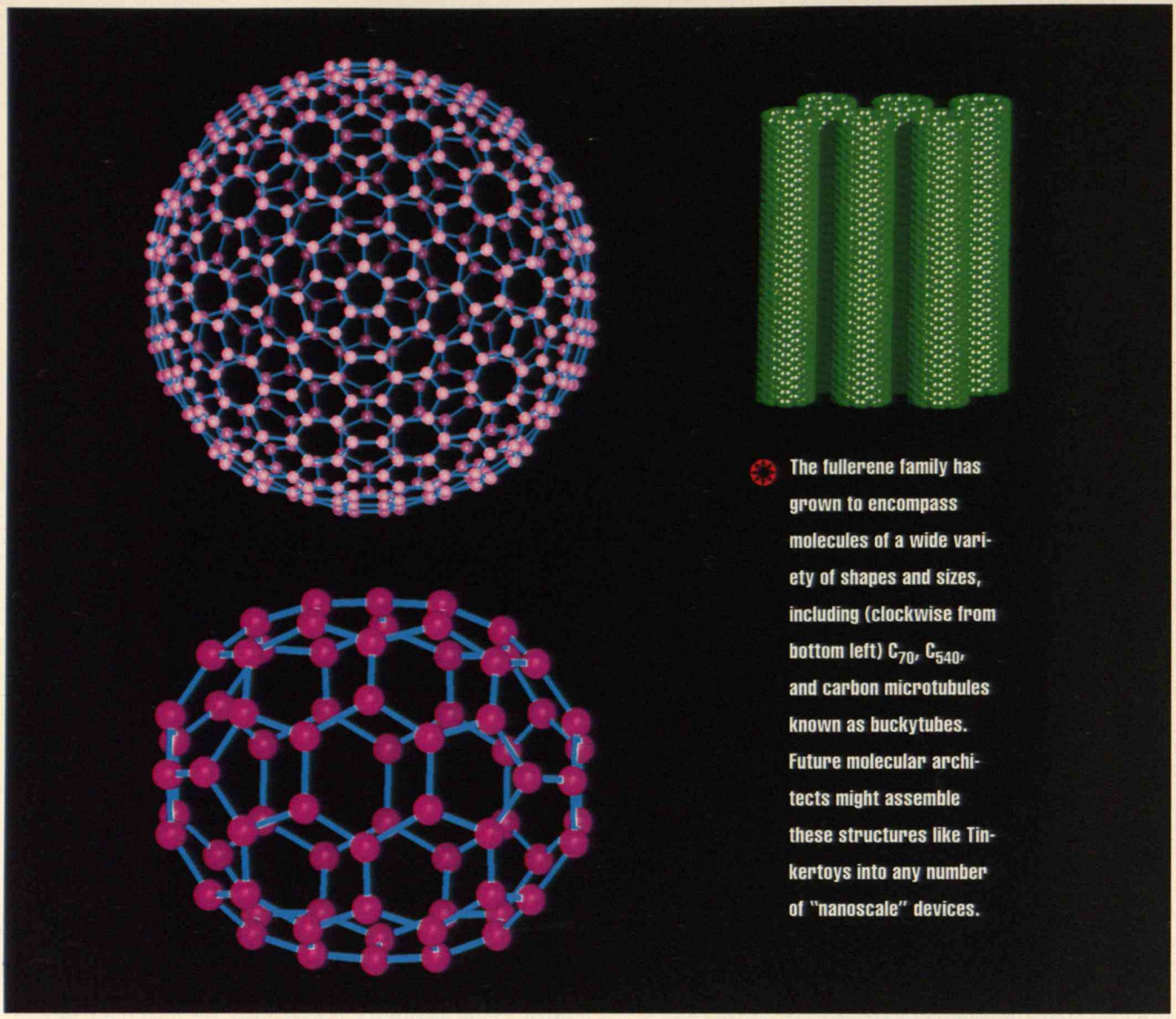
possible because a buckytube's electronic properties vary with its diameter and other dimensions. The difference is not chemical—as in copper insulated with PVC, for example—but entirely geometrical. In the spring of 1993, Iijima and others showed that by adding oxygen and other simple molecules, they could control the diameter of the buckytubes. This knowledge might provide the key to processes for making tubes "to spec."

The combination of great tensile strength and electrical conductivity opens up worlds of possible uses. At the macro level, bundles of buckytubes might serve as ultrastrong cables for transmitting electric power. But it is in microelectronics and the still-embryonic field of nanotechnology that buckytubes and buckyballs alike stand to make their biggest mark. Because of the ease with which a fullerene's electrical properties can be changed—either by modifying its geometry or by varying the proportion of metal "dopant"—it is tempting to speculate that carbon might form the basis of future electronic "heterostructures." In other words, a continuous stretch of fullerene could contain distinct regions offering insulating, semiconducting, conducting, and superconducting properties exactly where they are needed. Using techniques derived from today's chip fabrication processes, it might one day be possible to manufacture an entire electronic product as a single block of fullerene.

Consider a carbon-based calculator. The semiconductor properties of fullerenes would allow it to process data, and superconductor properties would allow it to function without energy losses. Another fullerene property—photoconductivity, or the ability to convert light to electricity and vice versa—might do away with the need for batteries or silicon solar cells to run the calculator. This property could also be parlayed into a fullerene light-emitting display. Buckytubes could form the wiring—and insulation—necessary to run electronic signals from keyboard to fullerene chip to display. Even the calculator's physical structure and casing could be made of fullerene.

Without the need to combine components made from different materials, there would be no expensive assembly process on a production line. All the manufacturing would be chemical, as in today's silicon chip fabrication. But unlike silicon, which is brittle and notoriously hard to handle, carbon is robust enough that devices made from it might be manufactured without special cleanrooms.

More significant, carbon's bonding properties are so well understood that fullerenes may let materials scientists and engineers design electronic devices with greater control over their precise structure than is allowed by silicon. This, in turn, opens up the prospect of miniaturizing electronic devices beyond anything possible with conventional materials. Already NEC's Iijima and



The fullerene family has grown to encompass molecules of a wide variety of shapes and sizes, including (clockwise from bottom left) C_{70}, C_{540}, and carbon microtubules known as buckytubes. Future molecular architects might assemble these structures like Tinkertoys into any number of "nanoscale" devices.

his colleague Pulickel Ajayan have used buckytubes as molds to cast metal wires that are just 1.3 nanometers, or billionths of a meter, across—a hundred times thinner than the thinnest wire found on silicon chips. NEC hopes to use such wires in ultrafine electronic circuitry.

The capacity of carbon to be manipulated at such fine levels suggests that fullerenes might find their ultimate application in nanotechnology—nanometer-scale machines and electronic devices that are only now being envisioned, not least by Richard Smalley, the codiscoverer of C_{60}. One goal of nanotechnology is to create self-replicating robots so tiny they can perform surgery on individual human cells or assemble products atom by atom. Could fullerenes, with their assortment of spheres and tubes, be the Tinkertoys out of which such devices will be assembled?

It is not difficult to imagine how this might be done. The scanning tunneling microscope, capable of manipulating individual atoms, could nudge carbon tubes into position, and electron beams could "weld" them. Other elements or chemical groups could be added at various points to control characteristics such as photo-, semi-, and superconductivity.

Such uses of fullerenes are, of course, many years off. Researchers are still trying to learn how to control the growing conditions of fullerenes to produce various forms of the molecules on demand, as well as how to manipulate them chemically and physically. Any attempt at carbon molecular architecture will probably require close collaboration among chemists, physicists, and materials scientists, and perhaps also molecular biologists, engineers, and architects.

Whether or not this nanotechnology role proves to be the one fullerenes were born to play, the prospect of such interdisciplinary teamwork would have warmed the heart of Buckminster Fuller, who argued for a more holistic approach in harnessing science, technology, and design to solve human problems. It seems only right that the catalyst for this convergence should be a molecule that bears his name.

PHOTOS: CLIVE FREEMAN, BIOSYM TECHNOLOGIES/PHOTO RESEARCHERS, INC.

Respecting the Rank and File

LIKE many people who write about engineering, I tend to think of "the engineer" as an archetype. The engineer of my imagination is a proficient, inquisitive, and ambitious person who creates, discovers, and produces in the manner depicted in the handsome magazines published by the major engineering societies. These periodicals feature wonderful technical achievements plus inspiring individual success stories, presented in stylish layouts with entrancing multicolored illustrations. They confirm for me a glowing image of the profession.

Reality, however, presents us with complexities that this pleasant paradigm cannot accommodate. There is a grimmer aspect to the profession—an undercurrent of alienation that reveals itself from time to time in the letters written to the professional societies by disenchanted members.

One such communiqué caught my eye recently, an anguished and angry letter that appeared in *The Institute*, a publication of the Institute of Electrical and Electronics Engineers. "The IEEE doesn't represent the needs of the majority of working engineers," declared the correspondent, who had spent 35 years developing radar systems and high-energy particle accelerators. The organization "adopts an elitist stance of what's good for academia and corporate management." As a result, he lamented, "only a small fraction of my peers have been or are members."

In fact, of the approximately 2.5 million Americans with an undergraduate degree in engineering—more than 1.5 million of whom are engaged in engineering work—only 750,000 are members of any of the major engineering societies. No more than one-third of engineering graduates engage in studies beyond the four-year bachelor's degree, and fewer than 20 percent bother to obtain professional licenses. These figures suggest a profession that is not fulfilling its potential.

A recent study of engineers in the Rochester, N.Y., area found that almost one-third do not share the commitment to work values that one ordinarily associates with engineering. They do not expect to be involved in exciting new technical developments nor do they aspire to significant personal success. They seek merely "a modest level of technical challenge combined with the opportunity for periodic promotion and their share of organizational recognition." They can best be described, according to the authors of the report, as a kind of engineering "rank and file." When I spoke about this study to a group of engineers who are active in, and concerned about, professional affairs, several of them termed the findings very discouraging.

But it will not do merely to deplore the lack of commitment that appears to be so widespread. Leaders of the profession must pay heed to the concerns of the alienated and make special efforts to bring them back into the engineering family. Failure to do so would potentially waste an enormous supply of talent; the history of engineering shows that many important contributions have been made by underlings, independents, malcontents, and mavericks.

The societies should encourage young engineers, and also older engineers in the lower career ranks, to attend meetings, join committees, and take part in establishing policy. Companies should encourage this kind of participation by providing engineers with time off and even by subsidizing their travels. Society dues are high; employers and society officials might devise creative ways to promote membership, thus cultivating a sense of professional citizenship. Engineering publications surely can find space among their coverage of exotic research to provide information that appeals to the rank and file. Some articles should cover developments in the nuts-and-bolts technologies that most engineers contend with every day. Other pieces could offer advice on topics such as pensions and job hunting.

Similar suggestions have been made many times over the years. Yet with society leadership naturally accruing to energetic "organization" people, movement toward democracy tends to languish.

From the rank and file to stars of industry and academia, the engineering profession contains a wide variety of people. While diversity can be a source of strength, we have to make sure that our differences do not foster destructive animosity. Leaders of the profession must empathize with those colleagues who do not rise to the top of power pyramids, and who do not give speeches at professional gatherings.

At the same time, one hopes that every engineer might take pride in the achievements of talented and ambitious colleagues, and relish learning about work at the frontiers of innovation. Mutual respect and unity of purpose are important, and engineers—from the elite to the rank and file—ignore this at their peril. ■

SAMUEL C. FLORMAN, a civil engineer, is the author of Engineering and the Liberal Arts, The Existential Pleasures of Engineering, Blaming Technology, *and* The Civilized Engineer.

PHOTO: L. BARRY HETHERINGTON

The Costs of Lean and Mean

THROUGH the 1980s, popular wisdom had it that small companies—lean, innovative, and technologically adept—fueled the country's economic growth and that multifirm production networks, both regional and international, were a boon for development. But as economists gain a better understanding of the changes sweeping over the globe, it appears that "small" is neither as beautiful nor as bountiful as we have been led to believe. And as networks proliferate, we are finding that there are losers as well as winners.

In the first place, large companies still account for the lion's share of economic activity. In the computer industry, for example, Census Bureau data show that more than 90 percent of all jobs and revenue comes from 5 percent of all companies—those that employ 500 or more people. Moreover, many small businesses that are ostensibly independent depend almost totally for markets, finance, and political access on the big firms to whom they supply parts and services.

Even California's Silicon Valley is not quite the triumph for "cowboy entrepreneurs" that legend has it. Yes, the region has more than its share of ingenious programmers, designers, and venture capitalists. But many work either directly for, or as subcontractors to, large companies like IBM and Lockheed, for the Department of Defense itself, or for Japanese multinationals.

The business system is increasingly taking the form of lean and mean big firms, downsized to their core competencies, connected by contract and by handshake to other businesses, universities, and governmental institutions around the world. These networks allow organizations large and small to pool their skills as well as their access to public- and private-sector partners. The most innovative of these networks have large corporations at their centers.

Small businesses do contribute to economic health. Because they tend to be less footloose than branches of multinational corporations, for example, small companies help create stable environments in rural and low-income areas. Small, technically sophisticated manufacturers offer workers a chance to build a reputation as reliable employees, thus making a region more attractive to global producers seeking qualified suppliers. This phenomenon accounts in part for the decision by Mercedes, Michelin, and other European companies to extend their production networks into the southern United States, home to many small manufacturers of auto parts.

But these cross-border partnerships also can subvert local and regional economic development plans. Many states, for example, ply overseas companies with incentives, such as generous tax breaks. Smart state governments at least try to extract a quid pro quo, obligating the company to hire local workers, for example, and to buy from in-state suppliers. In some cases, the company agrees that if it closes the factory, it will pay the state back the tax savings that it received.

When push comes to shove, however, such decisions are made in the company's home country. Executives at headquarters in Germany, say, or Japan must respond to economic and political constraints that have little to do with the needs of the community that benefits from this peripheral factory. And with legal responsibilities easily shifted from one member of a network to another, regional economic development programs may find it difficult to hold companies to their contractual word.

This lack of control has other manifestations. General Electric's aircraft division, for instance, supplies engine parts for the European Airbus. But with Europe's economy weak, the consortium that manufactures Airbus may well decide to stipulate that Airbus suppliers make all their parts in Europe. In that case, GE workers in Massachusetts and Ohio will be out of luck, not for any change in their productivity or in their states' business climate.

Thus these international business networks contribute to what is becoming the biggest wave of workforce insecurity since the Great Depression. And while the big companies that anchor these border-spanning production networks hire skilled employees for steady, high-wage work, firms on the fringes of the system offer mainly temporary and part-time jobs. "Flexibility" is achieved at the cost of job security.

Cross-border networking holds much promise, and we will in any case have to live with more of it in the future. The trick is to figure out how to civilize this latest managerial innovation—and that will involve radically rethinking all aspects of business regulation. Everything is up for grabs, from taxation to antitrust policy to local content requirements. Unfortunately, policymakers have barely addressed the ramifications of the new business networks and the resulting subordination of small companies.■

BENNETT HARRISON is a professor of political economy at Carnegie Mellon University. His book, Lean and Mean: The Changing Landscape of Corporate Power in the Age of Flexibility, *will be published in April by Basic Books.*

PHOTO: L. BARRY HETHERINGTON

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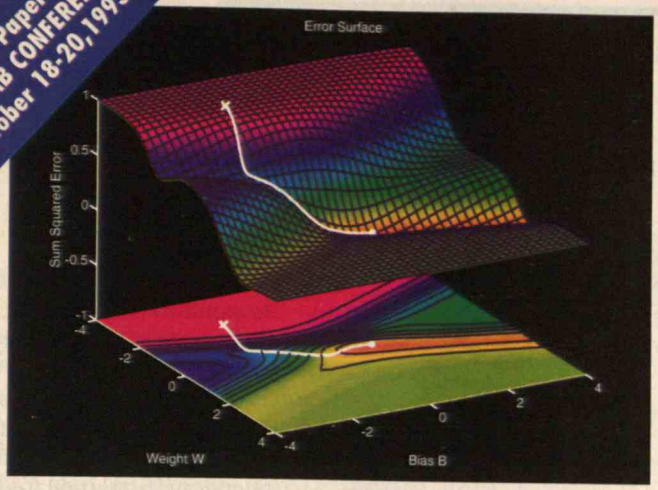

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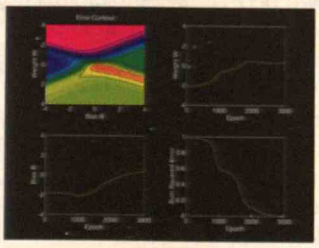

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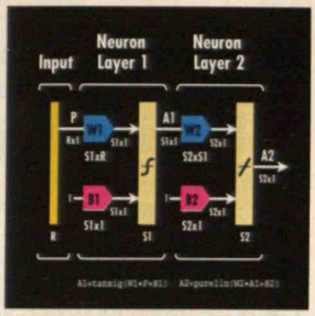

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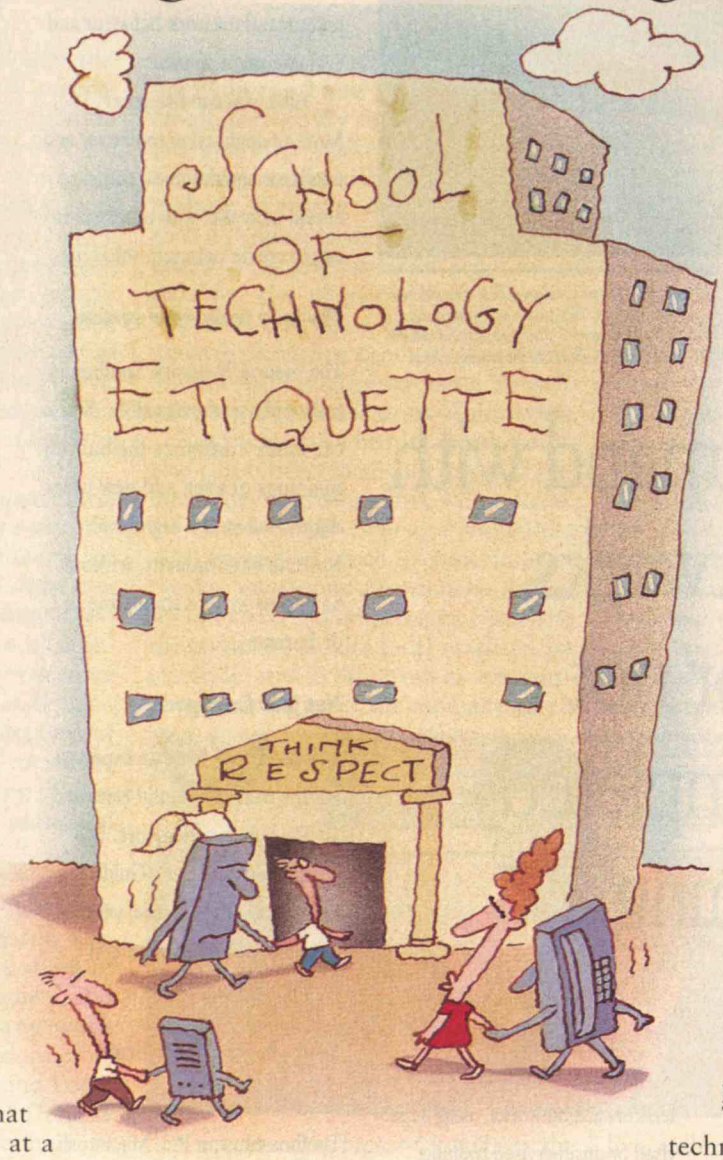
GARY T. MARX

Taming Rude Technologies

NEW communications technologies are arriving with rough edges in need of the sandpaper of manners. Consider these scenes:

- At a concert, the beauty of a violin solo is suddenly shattered by a ghostly electronic voice intoning: "George, call home." The person sitting next to you has forgotten to turn off his audio pager.
- Your fax machine runs out of paper after receiving a long, unsolicited fax. You miss several crucial messages as a result.
- A teacher receives a phone call at home on Sunday morning from a student requesting references for a term paper. The student interrupts the conversation three times to respond to call-waiting signals.
- You and a colleague disagree about what was said during an important phone conversation. You are shocked when your colleague says, "I know I am right because I taped it."
- You call to find out what time to pick up your child at a party. Although you have an unlisted phone number, the party host has Caller-ID and is also highly involved in charitable and political organizations. You soon begin receiving phone solicitations.

Traditionally, communications has involved interchanges between two people, in real time. But today a person often presents a monologue to a machine, which later delivers the message to another person—or to a large number of people. Such machine-mediated conversation can flood recipients with volumes of information that impose their own obligations. As a colleague asked me: "Am I really supposed to respond to 56 electronic-mail messages on Monday morning?"



Information technologies are opening new frontiers in rudeness. What's a gentleperson to do?

Our era is not the first to witness technology outpacing etiquette. When the telephone first appeared, callers had to determine under what circumstances it was appropriate to remotely intrude into another person's life. Was it permissible, for example, to call someone you had not been formally introduced to? Other questions of manners included the proper way to begin a conversation (AT&T advised against the informal "hello"), the acceptability of extending a social invitation by phone rather than by letter or messenger, and the suitability of having a servant dial (thus requiring the called party to wait for the servant to bring the caller to the line). Before direct dialing, social conventions also combined with phone-company policies to restrict the telephone operator's use of private conversations.

Today's communications technologies provide new opportunities and temptations for rudeness. Answering machines, for example, can subvert the presumed confidentiality of phone communications. Say, for example, you are visiting a friend who ignores a ringing phone, and a machine picks up the call and loudly broadcasts an embarrassingly personal message. Speaker phones raise similar problems. And call waiting (sometimes referred to as "call-us interruptus") poses other challenges. How long can a person politely be left dangling on the line while you check out the incoming call? If you ignore the call-waiting signal, is that inconsiderate to

ILLUSTRATION: JACK DESROCHER

the person trying to reach you?

By offering remote access and anonymity, new communications technologies also blur the distinction between etiquette and ethics. For example, electronic signals from cordless and cellular phones can be intercepted. E-mail and voice-mail messages are stored in digital archives that can never be 100 percent secure, and many people seem unaware that centrally archived backup records of e-mail messages may remain intact long after the user "deletes" them.

New technologies also present greater opportunities for deception. Miniature voice-activated tape recorders, tiny radio transmitters, and video cameras can be hidden inside everyday objects such as briefcases. With call-forwarding, we may not know where the other party to a conversation is, even if we initiate the call. Nor can we be sure that the signals and messages we receive are authentic. One phone on the market uses digital signal processing to offer 16 different voices, permitting shifts from female to male or adult to child.

These technologies will be subject to new laws, judicial interpretations of those laws, and bureaucratic policies. But it is not possible to legislate everything. Much social order is left to voluntary compliance with informal conventions. We therefore need new communications manners—ways of behaving that go beyond the purely legal and merely formal. And as we create social conventions to deal with communications technologies, it will help to keep some fundamental principles in mind:

- Do not deceive.
- Respect confidentiality.
- Do not impose costs on a party to a communication that he or she is unaware of or cannot control.
- Do not record communications without the knowledge and consent of the parties involved.
- Possession of technologies such as a phone, fax, or computer invites communication but does not oblige a person to respond to unsolicited messages.
- The initiator must respect the recipient's desire not to sustain the communication. (For example, you should graciously permit the person you called to take another call.)
- An unsuccessful effort to reach someone carries no obligation to leave a record of the attempt (you don't have to leave a message on an answering machine).
- Always request a companion's permission to engage in a conversation to which he or she is not a party (it is rude to use a car phone, for example, without checking with your passengers).

While such conventions develop, we can take a variety of actions to protect ourselves from rudeness and invasiveness. Telephones don't have to be answered, nor do faxes or answering machines always have to be left on. With a little practice one can even learn to ignore the call-waiting tone. Turning the volume down on an answering machine can prevent embarrassment when guests are present. We can avoid saying anything over the phone or fax that we would mind being heard or seen by others. We can even choose not to own an answering machine, subscribe to an e-mail service, or carry a pager.

Technological fixes are also available. In Europe, some phones have a warning light that goes on if an extension phone is picked up, deterring casual eavesdropping. Some fax machines keep a record of incoming messages even when the paper has run out. Public fax machines and printers, which disgorge their products for anyone to see, can be designed to generate documents only when the addressee is at hand to type in a password. Some pagers vibrate to signal that a message has been received rather than emitting an intrusive beep.

Heeding the principles embodied in such conventions and innovations—a golden-rule reciprocity and respect for the dignity of the other person—can help us preserve society's protective and pleasurable graces, even in the midst of technological change. ■

GARY T. MARX, a professor of sociology at MIT, is currently on leave at the University of Colorado.

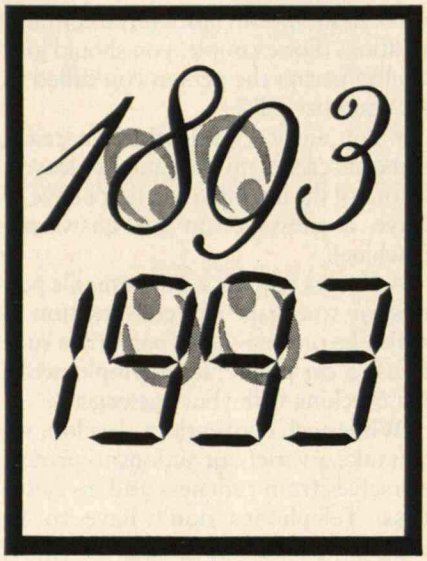
Reviews

BOOKS

THAT WAS THE YEAR THAT WAS

Today Then:
1993 as Predicted in 1893
compiled by Dave Walter
American & World Geographic Publishing
$12.95

BY ROBERT C. POST



In the early 1890s, the American Press Association—a ready-print syndicate serving newspaper editors throughout the country—commissioned futurist essays from 74 politicians, inventors, business entrepreneurs, labor leaders, literary figures, clerics, critics, and diverse celebrities. The subject: life in the United States 100 years hence. Entitled "America in the 1990s," the series was conceived as a prelude to the World's Columbian Exposition, which opened on the Chicago lakefront on May 1, 1893.

As historian Dave Walter tells us by way of introducing *Today Then*, his reprise of those essays, contributors were primed with 33 questions on topics such as politics, education, and religion; labor relations and "the servant problem"; temperance and divorce; and architecture, music, literature, drama, and "the English language."

Question 26 asked, "What will be the status of women—particularly regarding suffrage—in the 1990s?" Question 33 asked, "Will the race be happier, healthier, and handsomer in the 1990s than it is now?" Several questions related specifically to technology—communication and transportation, and "improvements, inventions, and discoveries in mechanics and industrial arts."

Some essayists tried to address all 33, others considered only one. Female respondents (there were six) were preoccupied with suffrage. Reformer Henry George keyed his predictions to the instigation of the "single tax," a levy aimed solely at landowners. John J. Carty, chief engineer of the New York Metropolitan Telephone and Telegraph Co., wrote exclusively about the revolutionary potential of electricity. If there was one prevalent response, however, it was the expression of grand imperialistic visions for the the United States. On the eve of the new century, Americans were looking forward to an age of vigorous expansion, and fully expected that dramatic feats of engineering would occur to make this expansion possible.

Tools of Manifest Destiny

Several essayists foresaw all of North and Central America, and maybe South America as well, under the stars and stripes. The vision of a "United States of the Americas" brought together politicos as diverse as Asa C. Matthews, Republican comptroller of the currency, and Kansas Populist senator William Alfred Peffer. Papermaking magnate William Miller foresaw a Nicaraguan canal, "as conspicuous an engineering triumph of the next century as the Suez Canal was of this—and as inevitable." Naturally, such a new canal would be under U.S. control, for, as journalist William E. Curtis baldly declared, "the manifest destiny of the United States is to dominate the hemisphere."

Even those not explicit about hemispheric domination often had something of the sort in mind. There were forecasts of a U.S. population of 300 million, 600 million, even a billion. Since the nation's population in 1890 was already 62.6 million, an assumption prevailed that the United States would need more room for all those people. In predicting that "millions of dwelling houses will be artificially cooled in summer, as they are now heated in winter," naturalist Felix L. Oswald seems to have been thinking of a mass migration to warmer southerly latitudes.

The squeeze on farmland only added to this expansionary thinking. President Benjamin Harrison's secretary of agriculture, Jeremiah M. Rusk, foresaw a 300 percent increase in the acreage under tillage. Since the existing arable land had largely been taken up, it would be important to expand the nation's boundaries.

Holding together the country's new, enlarged sphere would require a variety of connective devices. Giant irrigation schemes were a favorite, as was communication via networks of pneumatic tubes. Shipping magnate Alfred Van Santvoord predicted a system of inland waterways "every bit as extensive as the railway systems that control the great trunk lines." Kansas senator John Ingalls envisioned something more spectacular: the "subjugation of the atmosphere," with transcontinental or transoceanic flights "between sunrise and sunset of a summer day." Oswald likewise foresaw a solution to "the problem of aerial navigation."

These predictions notwithstanding, most forecasts of speedy transit were not only earthbound but also railbound. The journalist Curtis, for example, foresaw a railway from Buenos Aires to Chicago, which many guessed would be the preeminent city of 1993. Walter Wellman, an adventurer and journalist, took this idea still further, predicting

ILLUSTRATION: BRUCE MADDOCKS

railways that extended "to the uttermost parts of the continent, from Alaska to Patagonia." Of course, speed was of the essence. Along with a "North American Republic" embracing both Canada and Mexico, clergyman David Swing foresaw 100-mph travel even for "slow freight trains." Swing was not sure the trains would be driven by steam, and Treasury Secretary Charles Foster felt certain the motive power would be electricity "pumped out of the earth, or the sea, or the air," a concept he attributed to Edison.

Issues of the Day

In hindsight, these essays are a remarkable mix of prescience and naïveté. Yet as historian Joseph Corn has pointed out in *Imagining Tomorrow: History, Technology, and the American Future*, any exercise like "America in the 1990s" is less significant for how well it coincides with future reality than for what it says about the present in which it is conceived—how, in Corn's words, "people thought about their world, about social change, about themselves, and about their technology."

The predictions in *Today Then*—right, wrong, and indifferent—took shape at a time when "the closing of the frontier" was on eveybody's mind. Eighteen ninety-three was not only the year the nation belatedly celebrated the 400th anniversary of Columbus's voyage of discovery; it was also the year Americans became aware that the superintendent of the census had declared the era of "free land" (by which he meant land available for tillage) to be over. That same year, Frederick Jackson Turner, speaking to the American Historical Association in Chicago, would present an enormously influential paper in which he asserted that the existence of the frontier had been the prime determinant of American history.

The point is arguable, and indeed it has been argued ever since. But if one took Turner seriously, the implications were overwhelming. It seems scarcely a wonder that imperialistic visions were so ubiquitous, or that a new epoch of foreign adventure was just around the corner, not only in Central and South America but also in the Caribbean and the Pacific. "For nearly three centuries the dominant fact of American life has been expansion," wrote Turner in 1896. "That these energies of expansion will no longer operate would be a rash prediction."

To many people, predictions are rash by their very nature. Journalist J.H. Beadle wrapped up the American Press Association's series by ridiculing futurists like Edward Bellamy, author of the utopian novel *Looking Backward: 2000–1887*, and elaborating on "the futility of modern prophecy." Echoing these sentiments, editor Edward Cornish claims in a recent issue of *The Futurist* that "perhaps the safest forecast we can make about the world of 2093 is that it won't be like whatever we think it will be like. The more we commit our views to paper, the more ridiculous we will look to the people a century hence."

I think Cornish is selling his futurist enthusiasm short. In the same issue there appears a "Futurist Poll" that asks readers to assess the likelihood of "major hopes" concerning a nonaddictive "happiness pill," genetic engineering, universal language-translation technology, space colonization, and contact with extraterrestrials. Will such forecasts prove any more or less fanciful than those made 100 years ago? It doesn't really matter. One can read profound intimations of today's obsessions and foibles in all of them. The supposition of a world with no room for more people, for example, looms in our present consciousness much as "energies of expansion" did a century ago—and, if it proves misguided, will be no more difficult for tomorrow's historians to forgive.■

ROBERT C. POST is editor of the historical quarterly Technology and Culture. *He has recently completed* High Performance, *a book on the technology and culture of drag racing.*

BOOKS

FACING FALLOUT'S VICTIMS

American Ground Zero: The Secret Nuclear War
by Carole Gallagher
MIT Press, $50

BY ROBERT DEL TREDICI

WHEN physicists figured out how to make an atomic bomb explode, they decided to characterize what was going on in terms of kilotons of TNT. But reducing the Bomb's explosive force to firecracker power obscures more than it reveals, since a nuclear explosion has in fact no earthly frame of reference: the only other place such energy exists is inside stars. Over the past 50 years, we have invented, reinvented, tested, mass-produced, deployed, and proliferated the Bomb on many fronts; yet our experience of the actual thing itself has remained muffled and removed. A nuclear weapon, to this day, is not something we have ever been very good at expressing in human terms.

Carole Gallagher's *American Ground Zero: The Secret Nuclear War* changes that. It is an epic work that expresses the human significance of nuclear explosions at the Nevada Test Site in the 1950s and early '60s. In a hefty volume of photographs and interviews with America's Bomb-damaged nuclear first families, Gallagher, a freelance photographer from New York, brings us as close as we may ever want to get to the real thing.

In his introduction, Keith Schneider of the *New York Times* calls those atomic tests "the most prodigiously reckless program of scientific experimentation in United States history." He describes how, between 1951 and 1962, the U.S. government detonated 126 nuclear weapons in the atmosphere at

In college, Joanne Workman, one of Gallagher's subjects, lost all her hair after witnessing a Nevada atomic-bomb test. She later developed five different cancers.

PHOTO: CAROLE GALLAGHER

the Nevada site; how each explosion produced a fallout cloud that drifted beyond test-site boundaries with levels of radiation comparable to the Chernobyl cloud; and how for 30 years the U.S. government covered up the contamination and its consequences. For some, this may sound like old news. But for those whose lives were overtaken by the atmospheric tests, the news is still breaking today in hospital beds, judge's chambers, insurance offices, and obituary columns.

Terror and Deceit

The book's 78 subjects are culled from widening circles around ground zero. First we meet test-site workers, hands-on employees with special clearance who set the stage before the detonations and cleaned up afterward. Next come atomic veterans—soldiers sworn to silence and ordered to witness nuclear explosions at close range. The third and largest portion of the book is devoted to the "downwinders," the estimated 170,000 citizens within a 250-mile radius of the test site—not just in Nevada but also in Utah, Arizona, and New Mexico—who lived for years in the path of atomic fallout. Each story is presented on three levels at once: through Gallagher's own voice, which describes the setting and introduces the characters; through black-and-white portraits that draw us in and hold us steady for what we are about to hear; and through interviews that spell out chapter and verse the short- and long-term terror of the situation.

A truly primal terror sprang from the tests themselves. Robert Carter, an atomic veteran who was 17 when he witnessed a nuclear blast in 1957, recounts: "That cloud was like a big ball of fire with black smoke and some red inside, a big, monstrous, something almost sickening. Something that would scare you. It left me really sad, real apprehensive about life. . . . That explosion told me I was part of the most evil thing I have ever seen in my life."

The long-term effects of the testing have also proved devastating. The first photographic portrait in the book introduces us to test-site worker Ken Case, a man once called the Atomic Cowboy because he was hired to ride herds of cattle and horses over ground zero after nuclear blasts to test the effects of radiation on animals. At the time of the interview he and his wife were living in a trailer in North Las Vegas, where, we are told, they were dying of cancer. Gallagher's portrait shows Case gamely displaying a framed photo of an atomic explosion, holding the picture so the mushroom cloud's hot center is positioned over his heart. This opening portrait is an apt metaphor for others to come: one way or another, all those we are about to meet have had to come to terms with this same superimposition.

Scores of others in the book have endured similar or more gruesome illnesses, and in each case it is difficult to say which has caused more suffering—the diseases themselves or the government denials that the downwinders' condition was caused by fallout. "They decided there was nothing wrong . . . ," says the wife of test-site worker Eugene Haynes. "All of a sudden, his whole body, from the tips of his nails to the tips of his toes, broke out in boils and red-purple splotches. . . . He couldn't wear clothes. He would scream if anyone touched him. It was vicious, okay? Apparently there was a ruckus from Hiroshima at that time with this type of lesion. . . . They kept denying it to the very end that there was ever anything wrong with him."

The morning after an atomic blast, another interviewee recalls, "my lungs and my throat and my sinuses burned so badly, it felt like they had been scalded or seared. I went to see my doctor. . . . The nurse said, 'Now that goes with the radiation that's here. The [Atomic Energy Commission] told us to look for that but not to be worried; it will go away.' . . . The next day the top of my head began to feel like it was being stung with hundreds of red ants. And it wasn't long till my hair started falling out."

It's not easy to sustain interest in stories of victims whose woes are endless, but Gallagher's chronicle keeps its edge: each account is fresh, each one hits home, each somehow breaks new ground. In one image after the next, Gallagher captures the inner quiet of her subjects and the way they fill their living space. Her portraits imbue the book with an intimacy that stands in marked contrast to the horror of the text. And once we have read the interviews, we see the portraits differently. Faces that could belong to our next-door neighbors are seen on second viewing to contain a deep and bitter wisdom about something few Americans have ever imagined: what it's like to be trapped on home ground inside a protracted, limited nuclear war.

Portraits of Staying Power

To establish visual continuity with the region's past, Gallagher incorporates 10 photographs of Utah taken in 1953 by Dorothea Lange. The pictures show us daily life in the southern part of the state,

grounding us in the wholesome fields, streets, and homes of the Mormon West. Testing had begun two years earlier, but Lange's pictures show no hint that either she or her subjects were aware of the dangers. The fact that fallout was percolating down into this world as these very photos were being made creates an irony that needs no comment.

With these images Gallagher invites comparison between herself and Lange, whose pictures commissioned by the Farm Security Administration in the 1930s created a definitive view of migrant rural America. Lange's photographs emphasized the inner strength of farming families who had lost their land and livelihood. Like Lange, Gallagher aims to depict the inner state of her subjects, but her mission is more complex: she captures not the clear-eyed stamina of Dust Bowl migrants but the ambivalent staying power of citizens betrayed to the edge of extinction.

When one thinks beyond Nevada to other test sites and other nuclear arsenals, and to the thousands of radiation workers in nuclear weapons factories worldwide, and to the long-lived radioactive materials these sites still contain and sometimes release, it is clear that *American Ground Zero* is only one chapter in the long, dark aftermath of the Bomb. But perhaps it can be considered the chapter that best reveals the lethal human costs of nuclear weapons development.

Thirty publishers are said to have turned down Gallagher's manuscript before it saw the light of day in the form of this rarest of publishing events: an elegant coffee-table book that is easy to look at, takes nothing for granted, and strikes to the bone. While *American Ground Zero* is not the first book to be done on the downwinders, it stands a good chance of becoming the one people will turn to from now on to discover who downwinders are. ■

ROBERT DEL TREDICI is author of At Work in the Fields of the Bomb *(Harper & Row, 1987), a photographic profile of workers at U.S. nuclear weapons plants. He teaches photography at Vanier College in Montreal.*

Classifieds

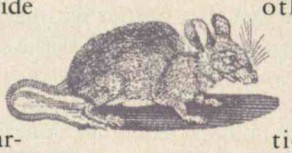
Phenomena

By David Brittan

READING THE STARS ❧ The key to answering one of the great questions of typographical history—when did Johannes Gutenberg first print?—may lie in astrology. For decades, bibliographers have been confident that the Gutenberg Bible, printed in the mid-1450s, was the first work of any consequence to be set by the inventor of movable type. But Noel M. Swerdlow has consulted the stars, and thinks not. Exhibit A is an early printed ephemeris, or almanac of lunar and planetary positions, used by medieval astrologers. Everyone—including Swerdlow, a professor of astronomy and astrophysics at the University of Chicago—agrees that the ephemeris shows positions for the year 1448. To Swerdlow, the work could have been produced only in 1447, seven years before the earliest dated specimen of typeset printing. Bibliographers, however, place the ephemeris considerably later. Typographically, it resembles several other printings, among them a Bible with pages of 36 lines each, generally thought to be the work of an inferior Gutenberg imitator in the late 1450s. Of course, explaining why an ephemeris for 1448 appeared a decade late requires some fancy footwork. In the 1940s, says Swerdlow, one Carl Wehmer reasoned that the ephemeris was not intended for use in any particular year. Rather, astrologers were supposed to add "mean motions" to the positions shown and thereby compute crude horoscopes for the next 20 or 30 years. To which Swerdlow responds: "Totally impossible. You end up with colossal errors of 60 and 80 degrees for Venus and Mars." Upending 50 years of received wisdom, he maintains that the ephemeris and perhaps the 36-line Bible represent an early, previously unknown stage of Gutenberg's work. The invention of typesetting would then move closer to the early 1440s. To bolster this conclusion, Swerdlow points out that after 1448 the ephemeris would have been "entirely useless for its intended application," which was not predicting the future but determining the best times for planting and harvesting, performing alchemy, and practicing state-of-the-art medical therapies such as bloodletting and taking laxatives.

HIS MASTER'S VOICE ❧ Ask a dog when is the best time to start wearing a hearing aid, and the answer will probably be "never." "Most dogs don't like stuff stuck in their ears," says A. Edward Marshall, a professor in the College of Veterinary Medicine at Alabama's Auburn University and co-developer of the Original Hearing Aid for Dogs. When Marshall and Curtis Smith, a now retired audiologist at Auburn, teamed up to restore hearing to deaf dogs, they first tried putting a conventional instrument directly into the ears of three different subjects. The results were disappointing. "Every one of 'em ate the hearing aids," says Marshall. Next the inventors enclosed the hearing aid in a special case whose narrow stem could be packed into the ear with plastic foam. "A few dogs would wear it, but dogs move their heads so rapidly that it tended to slide out," Marshall recalls. A couple of modifications later, they had a product that worked reasonably well: a hearing aid attached to the dog's collar with Velcro and linked to the ear by plastic tubing. That was five years ago. Despite hundreds of inquiries from all over the world and a high level of customer satisfaction, only eight to ten units are sold each year. The reason, says Marshall, is that few people are willing to go through the month-long training regimen necessary to overcome their dogs' finickiness about having foreign objects lodged in their ears. The suggestion that sales might double if the hearing aid were adapted for cats is greeted with stony silence.

MOUSE ARREST ❧ Did someone say "cats"? In cartoons, the very word may be enough to send mice scurrying for cover. But in the cruel world, controlling mouse infestations usually means setting traps or poisoned bait. Milos Novotny, a professor of chemistry at Indiana University at Bloomington, has devised a nontoxic, and presumably more humane, way to rid buildings of *Mus musculus*. Noting that male mice tend to stay away from territory marked with the urine of another dominant male, Novotny isolated the chemicals responsible: aromatic oils known as farnesenes, which mice detect with their sensitive noses. Farnesenes could be sold to consumers in a form resembling an Airwick bottle. In case some fearless males are undeterred, organic chemists have another trick up their sleeves. Research Corporation Technologies, a Tucson-based company that helps commercialize the fruits of university research, intends to mix the farnesenes with olfactory compounds that delay puberty in female mice. The next step is to find a firm willing to manufacture and market the product. So far, only nibbles.



THE ACCIDENTAL ALCHEMIST ❧ Michael Breslin, a materials-science student at Ohio State University, has inadvertently staked off some territory for himself in the field of composites. In 1989 he put aluminum in a ceramic crucible and heated it to over 1,000°C—well above the metal's melting point and "hotter than anyone would normally take aluminum." He intended to study oxidation in the metal once it had cooled. What caught his eye instead was the crucible, which had turned from snowy white to metallic gray. "I tried to break a piece off, but it took several heavy-duty blows with a sledgehammer to even crack the thing," says Breslin. Today, Ford, GM, GE, and several aerospace firms plan to use the aluminum-saturated ceramic, dubbed C^4, for making tough, easily molded mechanical parts.

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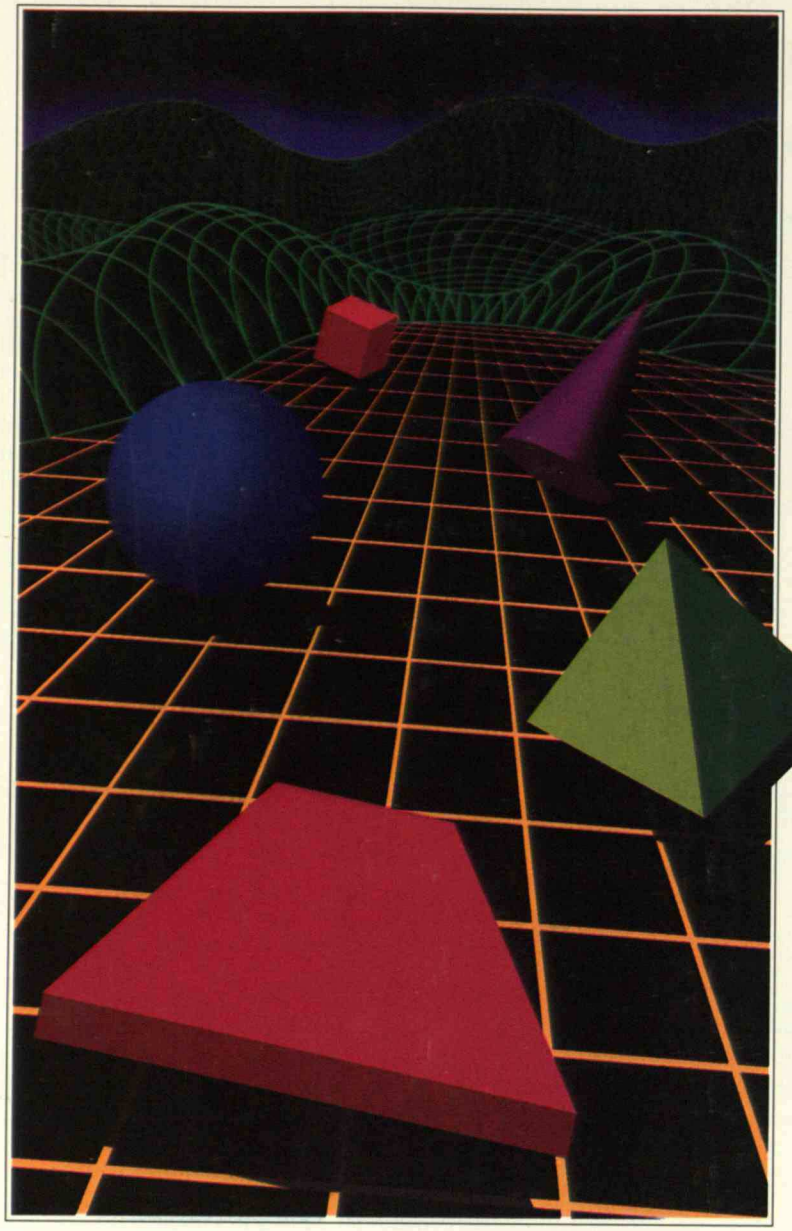

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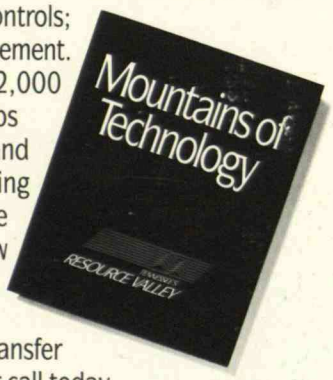

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